Activity Using the Process Workbook Spreadsheet Tool

A companion to
A Workbook for Distinctive Computer Science Curricula:
Designing Programs Aligned with Liberal Arts Institutional and Departmental Identity

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Introduction

This activity provides a hands-on introduction to the spreadsheet tool that has been developed as a companion to *A Workbook for Distinctive Computer Science Curricula: Designing Programs Aligned with Liberal Arts Institutional and Departmental Identity ("the Process Workbook").* The spreadsheet is intended as an aid to interpreting and adapting the ACM/IEEE/AAAI CS2023 recommendations within the framework of the workbook's six step curriculum design process. Steps 1-3 of the process have programs articulate their identity, design principles, and program-level learning outcomes. Step 4, including the spreadsheet tool, brings together the outputs from steps 1-3 with CS2023 to help identify the core CS content to be required in the curriculum. Steps 5 and 6 then guide programs through identifying specific curricular changes they will make and planning for assessment.

Scenario

This activity is structured around the scenario described in the box below. Additional scenario information will be provided in similar boxes as you progress through the activity.

Scenario:

During the last year, the CIS department at Washington & Jefferson College has completed Steps 1-3 of the *Process Workbook*, articulating their identity, design principles, and program-level learning outcomes. The documents provided in the appendix document the work that they have completed thus far.

Now, imagine that you have just been hired to join the CIS faculty at Washington & Jefferson and your new department chair suggests that you look at the work they have done so far so that you can join in on the next steps.

Review the department's documentation of the first three steps of the *Process Workbook* and answer the following questions:

1. What is an element of the program's liberal arts identity that you find particularly interesting or that connects to your own teaching and professional priorities?

2. Within the "Reflection on Mapping Identity, Design Principles, and Learning Outcomes" section, find a Key Concept at the top of that section that is linked with this element of the identity statement and then find a Learning Outcome designed to support that element of the program's identity.

3. What identity-driven design principle do you find particularly interesting or agree is an important curricular priority?

4. Within the "Reflection on Mapping Identity, Design Principles, and Learning Outcomes" section, find a Learning Outcome designed to support that design principle.

Stop here and wait to discuss your answers to questions 1 through 4.

Knowledge Area Emphases

Step four of the workbook guides the process of establishing curricular priorities and content in the context of the CS2023 recommendations. This work is guided by the first, ***"KA Emphases"*** tab in the Workbook Spreadsheet Tool, titled "Defining My KA Emphasis Relative to the CS Core".

CS2023 explains that “KAs” are ***Knowledge Areas*** that represent the various curricular topic areas that have been defined in CS2023, such as Algorithmic Foundations (AL), Operating Systems (OS), or Human-Computer Interaction (HCI). ***CS Core*** refers to the set of content that CS2023 requires that every student in the major will encounter, regardless of their path through the curriculum or selection of electives. The KAs are listed in the spreadsheet in the order of relative emphasis each one holds within the CS Core required by CS2023. This is also illustrated by the black dotted line in the radial diagram on the right, with radial length corresponding to the relative emphasis of each KA.

Scenario:

Your department has done an initial pass at indicating the relative emphasis they would like each KA to have within the required coursework of the major. The Percent of Curriculum shows what portion of the required coursework should be spent on each KA to achieve these levels of emphasis. The red line in the radial diagram allows you to compare your selected emphases to those in the CS2023 CS Core.

5. Looking at the radial diagram, where do you see the most deviation between the emphases of CS2023 versus the intended emphases of your department? For each significant deviation, does this seem justified by the department’s identity statement, design principles, or learning outcomes? Why or why not?

Adjusting Relative Emphases

A difficulty programs can have in rating emphasis is the difference between how greatly something is valued and how much time will be spent on it in required core courses. In this spreadsheet, emphasis will indicate the amount of time that must be spent on something, which is likely a combination of priority, time needed to instruct in the topic, time needed for students to practice the topic, desired depth of understanding of the topic, etc.

As an example of this difficulty, the current rating of emphasis for Society, Ethics and the Profession (SEP) seems to be rated too high.

Scenario:

Talking to your colleagues, it is clear that the SEP content is embedded across all core courses, showing its importance. However, the current selections indicate that 16.13% of required hours will be spent on this topic. You all agree that is too high and that its emphasis can be shifted down three spots.

6. Change the relative emphasis of the SEP KA in Column S to 7.0 by moving the checkmark in Row 9. Note that if you want to change where a checkmark is placed, you need to click on it to remove it and then click on the box where you want the checkbox to appear. When you are done, ensure that there is exactly one checkbox for the KA.

   What percentage of your required curriculum will you now be spending on the SEP KA?

Scenario:

You also discuss the role of the required databases course that your department agrees is an important part of their curricular priorities. Everyone likes the unique way that course covers some of the concepts in Software Development Fundamentals (such as data types, expressions, conditional statements, etc.) as well as some content from other KAs. So, while the course also covers topics from Data Management (DM), the entire course is not dedicated to Data Management topics. As a result, you all agree to shift that check mark for the Data Management KA down four spots,

7. Change the relative emphasis of the DM KA to 6.0.

   What percentage of your required curriculum will you now be spending on the DM KA?

8. What is the relative emphasis of the SEP KA now? Why do you think this has changed with respect to its value in your answer to question 6?

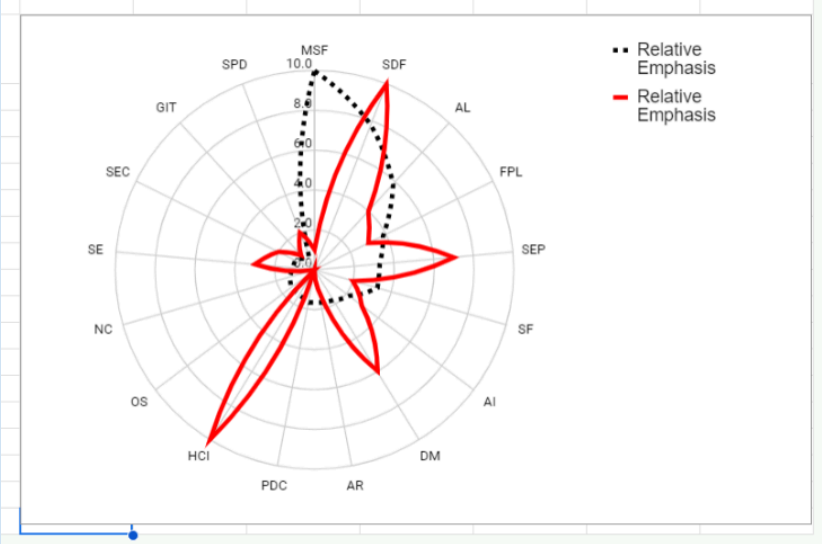
Scenario:

After all of the discussion and adjustments the department has settled on the relative emphasis shown below as their first estimates.

Defining My KA Emphasis Relative to CS Core

			CS2023		Relative Emphasis in My Curriculum										My Curriculum	
KA	Knowledge Area Name	CS2023 Recommended Hours	Percent of CS Core	Relative Emphasis	Omit	Least								Most	Relative Emphasis	Percent of Curriculum
MSF	Mathematical and Statistical Foundations	55.0	20.37%	10.0	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	1.0	1.82%
SDF	Software Development Fundamentals	43.0	15.93%	7.8	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	10.0	18.18%
AL	Algorithmic Foundations	32.0	11.85%	5.8	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	4.0	7.27%
FPL	Foundations of Programming Langauges	21.0	7.78%	3.8	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	3.0	5.45%
SEP	Society, Ethics and the Profession	18.0	6.67%	3.3	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	7.0	12.73%
SF	Systems Fundamentals	18.0	6.67%	3.3	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	2.0	3.64%
AI	Artificial Intelligence	12.0	4.44%	2.2	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	3.0	5.45%
DM	Data Management	10.0	3.70%	1.8	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	6.0	10.91%
AR	Archtecture and Organization	9.0	3.33%	1.6	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	1.0	1.82%
PDC	Parallel and Distributed Computing	9.0	3.33%	1.6	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	0.0	0.00%
HCI	Human-Computer Interaction	8.0	2.96%	1.5	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	10.0	18.18%
OS	Operating Systems	8.0	2.96%	1.5	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	0.0	0.00%
NC	Networking and Communication	7.0	2.59%	1.3	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	0.0	0.00%
SE	Software Engineering	6.0	2.22%	1.1	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	3.0	5.45%
SEC	Security	6.0	2.22%	1.1	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	2.0	3.64%
GIT	Graphics and Interactive Techniques	4.0	1.48%	0.7	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	1.0	1.82%
SPD	Specialized Platform Development	4.0	1.48%	0.7	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	2.0	3.64%

Add 1000 more rows at the bottom



9. The next exercises are based on the specific emphases agreed upon by the department. So, before you move on to the next steps, make sure that the relative emphases on your KA Emphases tab matches those shown above. Simply enter “Done” in the box below when you have completed this step.

Stop here and wait to discuss your answers to questions 5-8 and the resulting radial diagram.

Identifying CS Core Curriculum Content

The second tab of the spreadsheet,***"KA/KU Hours"*** begins the process of selecting required content for the curriculum. This tab combines the relative emphases expressed on the "KA Empahses" tab with information from CS2023 about the number of instructional hours in each KA. Working with this tab helps to interpret and adapt the CS2023 recommendations in principled ways based on the number of required courses in the program's curriculum and the emphases from the "KA Emphases" tab. .

Setting Available Instructional Hours

At the top of the KA/KU Hours tab, there is a section labeled "Instructional Hours Summary" that allows you to indicate how many instructional hours in your curriculum will be common between all students and thus can be considered "core" or "required." The default values in this section are set to reflect the assumption of CS2023 of 37.5 instructional hours per course and 7.2 required courses. Cell E6 shows that this works out to a total of 270.0 instructional hours available for covering required core content.

Notice that the "Total hours included in the CS+KA Core" (Cell E7) and "Total hours in My Allocation" (Cell E8) are highlighted in green. The spreadsheet will use highlighting such as this to indicate values that align (green) or misalign (yellow or red) with either the CS2023 recommendations or the size (Cell E6) and relative emphases (the KA Emphases tab) of the curriculum. The default values used in this section exactly match the CS2023 recommendations, thus both cells are highlighted in green. You will see other examples of how highlighting is used as you move through this activity.

Scenario:

Based on your program identity, design principles, and program-level outcomes, you now have departmental agreement on an initial estimate of the relative emphasis to be given to the various KAs in your curriculum. You are ready to move onto the "KA/KU Hours" tab of the spreadsheet.

The department currently has five required courses all students take, and three categories within which students must choose one course from a slate of electives. The electives in the same category share one quarter-course worth of common content/learning outcomes. This all adds up to 5.75 courses required for all majors.

In discussion, your department comes to a consensus that the present size and configuration of the curriculum are working well and allows students to explore electives and other areas of study. They value these properties and thus would prefer not to change the structure of the requirements at this time.

10. Update the value in Cell E4 to reflect the number of common courses in the curriculum.

    How many instructional hours are now available to cover all of the required content in the department's curriculum?

Selecting KA Content

The lower portion of the "KA Emphasis" tab contains a section for each KA. These sections appear in the same order as they did on the previous tab. Each section begins with a header row highlighted in blue. These rows contain the KA's abbreviation (Column A), its name (Column B) and some summary values (Columns E-U). The rows below each header show how CS2023 divides the KA's hours into finer grain Knowledge Units (KU).

We'll now consider several of the KA sections to understand the values that appear in Columns E-U and how they help with the selection of required core content.

A Well-Aligned KA

Consider the section for the Software Development Fundamentals (SDF) KA - second in the list. For now we'll focus on the highlighted values in Columns E, N and U. We'll see later how Columns G-K can be used to make adjustments.

- Column E indicates that CS2023 requires that 43 hours be spent on the CS Core content of the SDF KA.
- Column N indicates the number of hours of CS2023 content that the department has decided to include in its curriculum. In our terminology, ***"Included Hours"*** are determined from the KA/KU content you have selected to include. Note that this value defaults to the number of hours required by CS2023. Thus, at least for now, the department has decided to include all 43 hours required by CS2023, without making any adjustments.

- Column U shows that the program has allocated 39.2 hours for instruction of required content from the SDF KA. In our terminology, ***"Allocated Hours"*** are based on the hours available in the curriculum and the relative emphasis of the SDF KA..

Each of these values is shaded green indicating that they are in approximate alignment with each other (within 10%). More specifically:

- Column E being green indicates that the hours allocated to SDF (Column U) are aligned with the SDF hours required by the CS Core (Column E).
- Column N and Column U being green indicate that the SDF hours selected to be included in the curriculum (N) are aligned with the hours allocated to SDF (U) and vice versa.

11. Where did the allocation of 39.2 hours for the SDF KA come from? Hint: Recall that the relative emphasis for each KA indicated the percentage of the curriculum that should be dedicated to the KA.

An Over-Allocated KA

While the SDF KA was well aligned by default, this will not be true for all KAs. This section of the activity looks at a KA where there is some misalignment between the department's allocation and the CS2023 recommendation.

Scenario:

Recall that your department has set a very high relative emphasis for HCI as compared to what is required by CS2023. Thus, the department chooses to look at the alignment of the HCI KA next.

Scroll down to find the section of the spreadsheet for the HCI KA. Here, you can see that CS2023 expects 8.0 instructional hours on HCI (Column E) whereas you are allocating 39.2 instructional hours to the HCI KA (Column U). Both of these values are shaded bright yellow indicating a disagreement. More specifically:

- Column E is highlighted to indicate that the allocation (39.2 hours) exceeds the CS2023 recommendation (8.0 hours) by more than 20%.
- Column U is highlighted to indicate that the allocation exceeds the "Included CS+KA Core" hours (8.0) by more than 20%.

In addition, the number of hours included in the curriculum (Column N), is by default set to the number of hours recommended by CS2023. This column is currently highlighted bright red.

12. What does the bright red highlight on cell N94 indicate? Hint: There is a note associated with cell N11 that may help. Clicking on a cell with an associated will display the note.

This type of deviation from the CS2023 recommendations is an expected (and encouraged) effect of the workbook process. However, it is important to be explicit about what additional hours are included and why they are included.

Scenario:

The department refers to the details of the CS2023 document to better understand the topics that are included in each of the KUs within the HCI KA (e.g. “Understanding the User”, “System Design).

In doing so they learn that in addition to the required hours specified by the CS Core, CS2023 also specifies a KA Core. The *KA Core* identifies more advanced optional topics and recommends instructional hours for them. CS2023 suggests that these KA Core topics and hours be included in curricula that place an emphasis on the KA.

After reviewing CS2023 and discussing the HCI topics and hours included in the CS Core and KA Core, the department concludes that its strong emphasis on HCI justifies including all of the CS Core hours and adding all of the KA Core hours as well.

Column I indicates the optional KA Core hours that CS2023 recommends for each KU. For example, under the HCI KA heading there are 5.0 KA Core hours recommended in the “Understanding the User” KU. Column J provides a checkbox to indicate that the KA Core hours for a KU are to be included in the curriculum.

13. Click the checkboxes to include all of the KA Core hours for HCI.

    How many instructional hours are you now including in the curriculum from the CS Core and KA Core topics? What color is cell N94 shaded now? Why?

Scenario:

Even after including all of the optional KA Core instructional hours, there are still more hours allocated to HCI (Column U) than have been included in the curriculum (Column N).

The department again reviews the details of the CS2023 document and discusses its learning goals for each of the topics in the CS Core and KA Core HCI KUs. During this discussion, a

consensus emerges that the department will prioritize significant active learning and hands-on practice with the topics in the “Understanding the User” CS Core KU and in the “Accessibility and Inclusive Design” KA Core KU. This will require additional instructional time. Some intense debate settles on adding 5 hours to the “Understanding the User” CS Core KU and adding 4 hours to the “Accessibility and Inclusive Design” KA Core KU.

The cells in Column G can be used to include more or less hours associated with topics in CS Core KUs. The cells in Column K work similarly for KA Core topics.

14. Make adjustments to Cells G95 and K97 to add the additional hours that the department has decided to include.

    Explain the change to the highlighting in cell N94.

Stop here and wait to discuss your answers to questions 10 through 14.

Reevaluating Relative Emphases

While the adjustments you have made moved the hours included in the curriculum closer to aligning with the emphasis for HCI set on the “KA Emphasis” tab, it is still off by somewhere between 10-20%. The light red shading of Cell N94 and the light yellow shading of Cell U94 indicate this disagreement.

Scenario:

The department engages in more discussion about the amount of time to spend on the topics in the HCI KUs. While continuing to add hours to the HCI KUs is one approach to improving the alignment, someone points out that the total hours that have been included in the curriculum (Cell E7) is still highlighted bright yellow. Thus, eventually a lot of hours are still going to need to be “unincluded” from KA’s in order to fit within the overall 215.6 hours available.

With continued discussion your department agrees that this is a sign you will need to slightly reduce the relative emphasis on HCI within the required coursework, understanding that you can still include additional content within electives.

15. Adjust the relative emphasis for HCI on the “KA Emphases” tab. What is the impact on the alignment for the HCI KA on the “KA/KU Hours” tab?

Scenario:

As a side effect of the discussion around the relative emphasis that should be placed on HCI, a consensus emerges that the KA Core content in the “Evaluating the Design” KU should be elective and not required.

16. Make this adjustment and then adjust the relative emphasis for HCI so that the included hours and allocated hours align within 10%. What is the new value for “My Allocation” in Cell U94?

17. Notice that even though the included and allocated hours now balance Cell E94 is highlighted in bright yellow. Why is this cell still highlighted?

Stop here and wait to discuss your answers to questions 15 through 17.

Under-Allocated KAs

In the previous section you balanced the HCI KA. HCI is a central element of the Washington & Jefferson curriculum and thus, had a very high initial estimate for its relative emphasis. This resulted in many more hours being allocated to HCI (Column U) than are required by CS2023 (Column E). The opposite also occurs, where there are also KAs where your allocation of hours to a KA (Column U) is much less than what is required for that KA by CS2023 (Column E). In these cases you will need to use some combination of “unincluding” hours in the KA by using negative adjustments and increasing the relative emphasis of the KA to balance the hours.

18. Find three KA’s where the relative emphases selected by the department resulted in at least 20% fewer hours being allocated than are required by CS2023. Which KA’s did you find? What makes them easy to identify?

Scenario:

The department discusses some of the KAs where the allocation based on their relative emphasis estimates resulted in allocating many fewer hours than CS2023. There is still a

consensus that the relative emphases and their differences from CS2023 are supported by the program's mission and identity. However, after the experiences balancing the HCI KA, they recognize that some adjustments will be necessary in these KAs as well.

The discussion focuses first on the Mathematical and Statistical Foundations (MSF) KA. There is strong agreement that the department does not want to require a math course, but instead will embed the necessary math content into the relevant required courses. After some spirited debate the department identifies the math content they believe is necessary for their program as 1 hour on logic and 4 hours on distributions, sampling methods, and the t-test. They then review the topics required by CS2023, and see that it contains some other content that they can't imagine a CS graduate not knowing, and decide it should be required as well. They estimate that these additional topics will add another hour of Discrete Mathematics and two more hours of Statistics.

19. Identify the relevant MSF KUs and make negative adjustments in Column F that reduce theCS Core hours (Column E) to reflect the department's decisions.Then adjust the relative emphasis placed on MSF so that it accurately reflects the time the department has decided to dedicate to this KA. Your goal is to have your included and allocated hours fall within 10% of each other. What adjustments did you make?

Fine Grained Allocation Adjustments (optional)

You have been successful in getting the included and allocated hours in the SDF, HCI and SDF KAs to balance to within 10%. However, most often these hours will not be exactly equal. Usually this is good enough for planning purposes, and that is consistent with the purpose of this tool as a design aid. But there may be situations where it would be nice to account explicitly for a few additional or a few less hours in some KAs. The "Allocation Adjustment" column provides the ability to do this by allowing you to move some hours between KAs, deducting hours from one and adding them to another.

Scenario:

The department notices that while the included and allocated hours for SDF match to within 10%, there are still more hours included than are in the allocation. They consider increasing the relative emphasis of SDF, but it is already at the maximum value. Someone points out that the adjustments made to HCI earlier gave an allocation with 0.9 more hours than are included and that we could "steal" that time from HCI for SDF.

20. Pick a KU in the HCI KA and take 0.9 hours from it by entering -0.9 in Column T. What happens to the value in Cell T7?

21. Add the 0.9 hours stolen from HCI to one of the KUs in SDF. What happens to the value in Cell T7?

22. Find a few other KUs where hours can be stolen to better balance SDF and move them using “Allocation Adjustment”s. Why is it ideal to keep Cell T7 equal to 0 as you make “Allocation Adjustment”s?

Stop here and wait to discuss your answers to questions 18 through 22.

Wrap Up

You now have experience with all of the elements of our spreadsheet tool for working with CS2023. If you would like to continue experimenting, there are suggestions of other things you can try below.

23. Before you leave this activity, take a few minutes to reflect on your experience with the activity and the spreadsheet tool. What worked well for you, and what was confusing? To what extent does this tool help you think about curricular decisions? To what extent does this seem like a useful way to work with the CS2023 recommendations?

If you would like to try this out with your own program, you should start by working through the first three steps in our curriculum design Process Workbook. As you’ll have observed, having clarity about your program’s identity, design principles, and learning outcomes is an important prerequisite to your decision making about relative emphasis of KAs and content inclusion. A copy of *A Workbook for Distinctive Computer Science Curricula: Designing Programs Aligned with Liberal Arts Institutional and Departmental Identity* is available on the following page, along with other content related to this project: https://computing-in-the-liberal-arts.github.io/CS2023/

If you are interested in having a member of our group guide your program through our curriculum revision process, we are beginning to provide facilitation support through site visits and may be offering virtual facilitation as well in the future. Contact Amanda Holland-Minkley at amh@washjeff.edu to learn more.

Other Things to Try

If you have more time here are a few things you might try. They can be done in any order.

Balance the Algorithmic Foundations KA

Scenario:

The department's discussion turns to the Algorithmic Foundations (AL) KA next. Looking at the radial diagram again helps keep their focus on SDF, HCI, SEP and DM centered in the discussion. Based on this perspective and a review of the topics in the AL KU in CS2023, they conclude that most of the KA Core content on Foundational Data Structures and Algorithms should be included, and that the other three KU's can be de-emphasized but they aren't yet in full agreement on the hours and decide to use the tool to explore some possible scenarios to help gain clarity..

24. Find two different ways that adjustments can be made to the AL hours and/or its relative emphasis that balance the included hours (Column N) with the allocated hours (Column T). What adjustments did you make?

Adjust the Number of Required Courses and Emphases

Scenario:

Due to a steady increase in demand for CS courses, your department has been approved to hire a new faculty member. After advertising and doing interviews you are able to hire an amazing new colleague. This colleague works in the area of HCI but with a focus on wearable technology. Everyone agrees that this is an emerging area of importance and that it would be ideal for all students to have some exposure to this topic. Most of the additional courses added by the increase in faculty line will be used to add additional sections of existing courses. However, there is now enough capacity to add another 1.5 courses of required content to the major.

25. Adjust the relative emphases on the "KA Emphasis" tab to include the strengths of your new colleague. Also adjust the number of required courses in Cell E4 to reflect the decision to increase the number of hours of required content. Finally, try to rebalance some of the KAs that you have worked on before (SDF, HCI, MSF, AL).

Express Yourself

Scenario:

The College offers an amazing early retirement plan and all of the senior faculty sail off into the sunset leaving you as head of the department. You miraculously make some amazing hires immediately. Over the next year it becomes clear that the current curriculum no longer matches the strengths and priorities of the current faculty.

26. Use the “KA Emphasis” tab to create a radial diagram that expresses the relative emphases for your dream program. Give a brief discussion of why your diagram differs from the diagram for CS2023.

Appendix: Sample Workbook Results, Steps One through Three Computing and Information Studies, Washington & Jefferson College

Step One: Articulating Your Identity

Washington & Jefferson College (W&J) is a BA-granting institution of approximately 1200 students in Washington, PA serving a mostly-regional student population but with a moderate cohort of national and international students as well. The college mission emphasizes integrity, lifelong learning, and global citizenship. College-wide student outcomes further emphasize interdisciplinary thinking, individual agency, and a commitment to local and national communities. Recent curricular changes have added ethical leadership and practical experience requirements for all students. Students are also required to complete two courses of study (a major and minor or a double major) and are advised to select these programs to reflect a pursuit of learning that is both practical and liberating, reflecting both their professional and intellectual goals.

The Computing and Information Studies (CIS) program was founded in 2002 to offer an interdisciplinary computing program that prepares students to use computing in support of any career or graduate education path they pursue and that supports interdisciplinary uses of technology across the college. This mission is reflected in the composition of the faculty which includes tenure-track faculty with doctorates in English, Education Technology, and Physics as well as Computer Science.

Our identity as a liberal arts computing program is to emphasize computing practices in interdisciplinary contexts and to view our students as interdisciplinary learners whose computing education will complement and be complemented by their studies in other programs. By prioritizing computing in context, we also emphasize a focus on the end user/consumer and the

individual/social impacts of technology. We do not assume all students come to computing with the same values and priorities nor that they will all graduate with the same career and life goals.

Step Two: Stating Your Design Principles

Identity-driven design principles:

1. Major should have multiple entry-points that anticipate the range of interests and computing backgrounds of students, including low- or no-code entry points that count towards major requirements. (DEIA)
2. Program should offer courses of interest to students in other programs that can provide value as stand-alone courses or serve as entry points to the major or minor.
3. Courses in the major should support the college-wide curriculum or other programs where possible.
4. Major should be easy to pair in a double-major with any other program on campus.
5. Major should offer multiple pathways to complete requirements that allow students to emphasize in areas they prioritize while still covering core computing skills. (DEIA)
6. Major requirements should be defined around skills and competencies instead of content areas.
7. Major should minimize the length of pre-requisite chains to make upper-level coursework accessible to minors and non-majors and make it easier to complete the major if it is started as a sophomore or possibly junior.
8. Major should include applied and interdisciplinary projects at multiple points in the curriculum, including student-designed projects. (DEIA)
9. Major should scaffold support for independent, creative problem-solving across the curriculum from the 100-level up to the 400-level.

Structural design principles:

10. Major must be able to be offered by 4-5 full-time faculty.
11. Major should be limited in size, ideally 10-12 courses.
12. Major must be reasonably easy to complete whether begun in the freshman or sophomore year. (DEIA)
13. Major should be accessible to transfer students and able to be completed in two years if three prior CIS courses have been completed.
14. Major should minimize pressure to offer low-enrollment courses in order to keep students on track for graduation.
15. Major should enable faculty to occasionally teach in programs outside the department such as First Year Seminar, Gender & Women's Studies, etc.
16. Course design must consider how limited budgets (both at the College and for individual students) will affect what equipment, software, etc. are used.

Step Three: Articulate Program-Level Learning Outcomes

Catalog language about program goals:

> Designed to be an interdisciplinary program, the Computing and Information Studies curriculum comprises aspects of history, sociology, psychology, communication, art, design, science, and mathematics. The program stresses problem-solving and effective

communication skills while addressing issues in computational thinking, visual culture, interaction design, information management and analysis, systems development, and security.

Existing program-level student learning outcomes:

- Research and analyze an I.T. challenge and make sound recommendations regarding its solution
- Implement robust and well-documented I.T. solutions that respond to specific user requirements and that anticipate future needs
- Work as a productive member of a team to accomplish project goals; to plan and schedule project components effectively; to communicate clearly to a variety of audiences in both written and oral forms about the progress, status, and results of an I.T. project.
- Act ethically in the execution of all these objectives.

Possible additional or subordinate student learning outcomes:

- Students will be literate in the foundations of database development, programming, and visual design.
- Students will be able to assess the social or historical context of a piece of technology and analyze the relationship between that context and the creation and adoption of that technology.
- Students will be able to demonstrate skills in coding and production through the completion of a significant implementation or construction project requiring planning, review, and revision.
- Students will be able to demonstrate skills in analysis and modeling by using appropriate methods from data science, networking, systems analysis, or related disciplines to test, evaluate, document, and recommend solutions to real-world problems.
- Students will be able to demonstrate skills in design and interaction by designing user experiences, content, or systems that are both aesthetically pleasing and intuitively useful to varying audiences.
- Students will be able to identify relevant stakeholders to a technology and effectively investigate and document their needs.
- Students will be able to apply these foundational skills in the execution of an applied problem drawn from an organization or another discipline, both independently and collaboratively.

Reflection on Mapping Identity, Design Principles, and Learning Outcomes

Key Concepts in our identity statement:

A. Interdisciplinary computing
B. Computing in context
C. Focus on end user/consumer
D. Focus on individual/social impacts of technology
E. Breadth of student values, priorities, career and life goals

Primary Learning Outcomes:

PLO #1: Research and analyze an I.T. challenge and make sound recommendations regarding its solution

Supports: Identity Statements A, B; Design Principles 8 and 9

PLO #2: Implement robust and well-documented I.T. solutions that respond to specific user requirements and that anticipate future needs

Supports: Identity Statements B, C

PLO #3: Work as a productive member of a team to accomplish project goals; to plan and schedule project components effectively; to communicate clearly to a variety of audiences in both written and oral forms about the progress, status, and results of an I.T. project.

Supports: Identity Statement E

PL0 #4: Act ethically in the execution of all these objectives.

Supports: Identity Statement D

Subordinate Learning Outcomes:

SLO #1: Students will be literate in the foundations of database development, programming, and visual design.

Supports: Identity Statement E; Design Principles 1, 9

SLO #2: Students will be able to assess the social or historical context of a piece of technology and analyze the relationship between that context and the creation and adoption of that technology.

Supports: Identity Statements B, D

SLO #3: Students will be able to demonstrate skills in coding and production through the completion of a significant implementation or construction project requiring planning, review, and revision.

Supports: Design Principles 5, 6, 8

SLO #4: Students will be able to demonstrate skills in analysis and modeling by using appropriate methods from data science, networking, systems analysis, or related disciplines to test, evaluate, document, and recommend solutions to real-world problems.

Supports: Identity Statement A; Design Principles 5, 6

SLO #5: Students will be able to demonstrate skills in design and interaction by designing user experiences, content, or systems that are both aesthetically pleasing and intuitively useful to varying audiences.

Supports: Identity Statement C; Design Principles 5, 6

SLO #6: Students will be able to identify relevant stakeholders to a technology and effectively investigate and document their needs.

Supports: Identity Statement C

SLO #7: Students will be able to apply these foundational skills in the execution of an applied problem drawn from an organization or another discipline, both independently and collaboratively.

Supports: Identity Statements A, B, E; Design Principle 8, 9