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Assessing the Adventure: Strategies for Sustaining Student Success

There are few joys greater than entering a classroom and having the privilege of sharing the myriad ideas that made us fall in love with our fields. As experts in our areas, it is easy to get carried away; easy to drift into our own favorite topics at the expense of others. As guides, we lead our students on their own adventures by using our experiences and knowledge, but if we are not careful, then each semester we risk disconnecting our courses from the greater objectives towards our own niches, away from the needs of the students in the program.

This may not be the most exciting teaching strategy, but it is one that has helped keep my material grounded and purpose-driven. This is what I do to know I am guiding my students in the best way possible, and not simply exposing them to my own particular interests. This ensures that the day they walk across the commencement stage, I have done my best in training them to join me as a colleague in this discipline, in the manner that they deserve.

For this strategy, I shall very briefly summarize how I stay focused on the overall objectives and course outcomes, how I use immediate feedback to make adjustments as the semester continues, and how I track student success over time so I can improve components of my courses for future semesters, using a data-driven approach for objective assessments.

Using a Compass to Set the Path

Keeping up with our fields through research and academic papers is essential; however, it is so easy to focus on our own specific disciplines that we can often forget where the students are and what each of our courses should focus on for the greater good. To ameliorate this predicament, I use a compass. Like with hiking, I do not need anyone to tell me how to pack, dress, prepare, or walk. I have experience in all these areas, however, without a compass, it can be easy to head, confidently, in entirely the wrong direction.

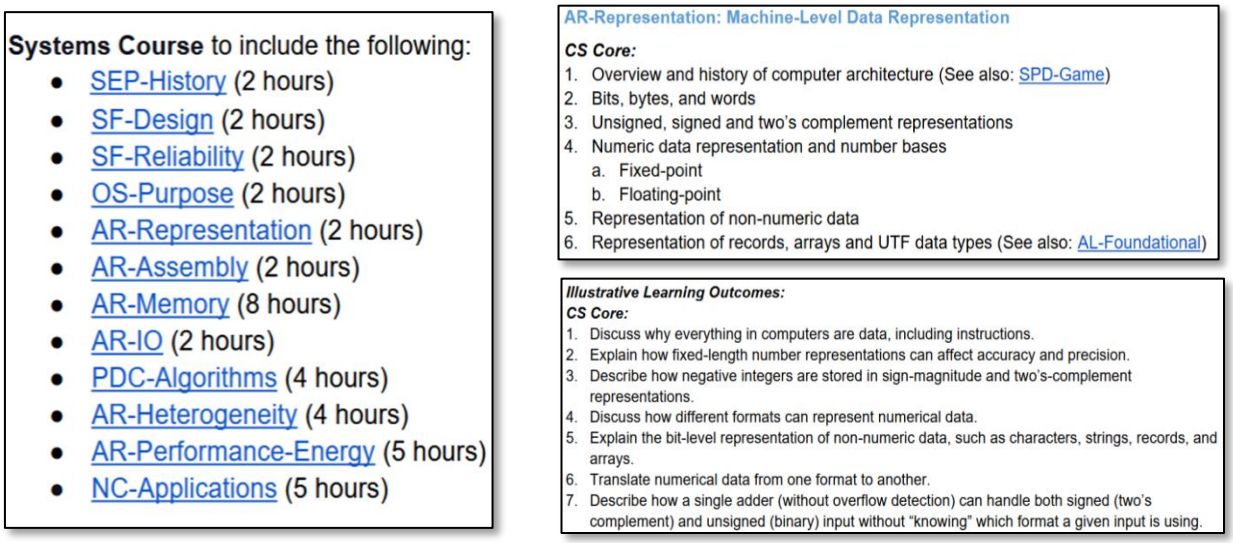

Figure 1: CS Curricula 2023

Figure 1 shows selections from CS Curricula 2023[1], which is a decennial product by a joint task force of the leading societies in my field with both academic and industry representation. This work provides me with an objective compass to ensure my courses continue to meet the needs of the larger community, while also ensuring the individual topics remain up to date.

With a compass, I now create or update my Student Learning Objectives to ensure that I provide complete coverage of the salient topics that I know to be important and that lead in the proper direction. To support these, I further create Enabling Learning Objectives, which are lists of actionable tasks and techniques that together lead to the larger outcome.

Topic	SLO #	SLO	ELO	Rationale
Floating Point	22	Convert Between Real Numbers and IEEE 754 FP Encodings	Describe Fractional Binary Representation of Real Numbers	Understand how Fractions are Represented in Binary
			Describe the Components of an IEEE 754 Encoded Value	Understand the Sign, Mantissa, and Exponent Components
			Describe the Three Cases of Values of IEEE 754 Values	Understand the Limits and Scope of Normalized, Denormalized, and Special
			Convert between Real Numbers and IEEE 754 Encodings	Understand how to Perform Conversions with Respect to the Limits of 754
			Describe the Rounding Technique Used in IEEE 754	Understand Round-To-Even
	23	Perform Arithmetic Operations on IEEE 754 Values	Describe how to Multiply two IEEE 754 Floating Point Values	Understand the Process for Multiplying two floats by Hand
			Describe how to Add two IEEE 754 Floating Point Values	Understand the Process for Adding two floats by Hand

Figure 2: My Related Student and Enabling Learning Objectives to the Demonstrative Curriculum Topic

Figure 2 shows how I take one item (4.b.) from the CS Curricula and apply it as an actionable item for my course. Here I have used my background to determine two important objectives that students should meet, and then determined the aspects needed for students to be able to meet that objective. Now I have the path to update my course plan, lecture materials, and related resources to ensure coverage. This ensures I have not built a spotty foundation.

This work is also weighed against the Course and Student Outcome requirements from our accreditation agency, and any changes are discussed with instructors for pre-requisite and follow-on courses, to ensure we are all aligned with our expectations and student needs.

Ultimately, when building student evaluation products, I aim for a uniform and fair selection of Student Learning Objectives (SLO) and will pick from the Enabling Learning Objectives (ELO) to write my questions, knowing that they have learned these in the course.

Checking the Path for Soundness

The best laid plan is seldom one that works on the first iteration. While students are eager for the grade on each evaluation product, I am most interested in the overall metrics. Did each class do well? Where did they have difficulties with this project? What do I need to reinforce? How did my lecture or materials fail my students in this area? What needs to be fixed?

To answer these questions, I capture metrics for each assignment in as fine a level of detail as possible, preferably at the ELO level, so I can make corrections or adjustments before the next evaluation. It is critical to know students are weak in an area, so their foundation can be corrected before they move forward with their education, and into the wider field.

[1] https://ieeecs-media.computer.org/media/education/reports/CS2023.pdf

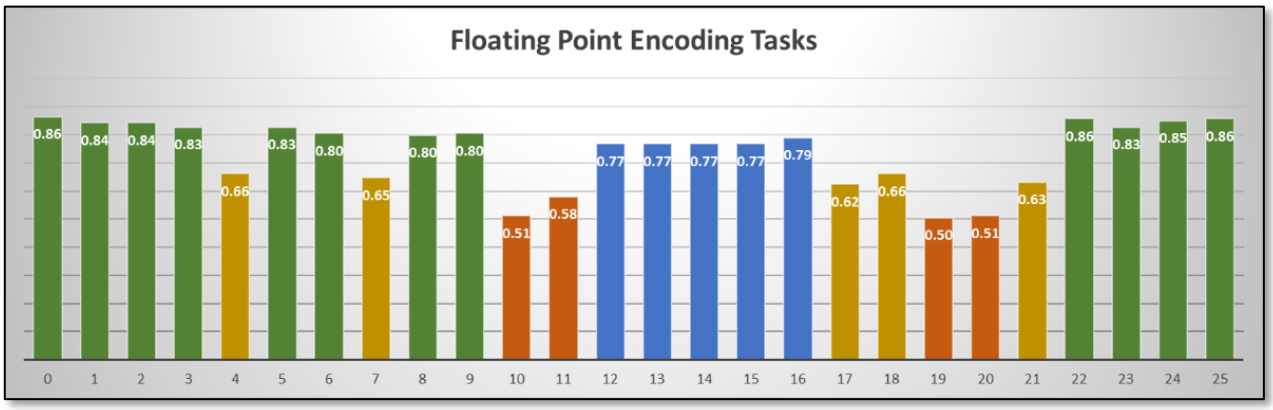

Figure 3: Project 2 Test Case Assessments

Figure 3 shows the test cases related to the objectives listed in Figure 2 for the project associated with the demonstrative objective. This is a quick view of where students struggled with their work, and with their overall thinking. Each number represents a test case, with the bars showing the average score. Tests 12-15, for example, represent Rounding (ELO), which was generally successfully implemented, while Tests 10 and 11, on the other hand, represent Denormalized Conversions (ELO), that were missed by half of the class. This provides me with information that this topic needs to be reinforced in class, or through other means.

Forging a Better Path for the Future

At the end of each semester, I take the largest step in this process, which is adding all the metrics to a data store, so I can look for larger trends in the students and in how I am teaching. This product is one of the most important for reflection before beginning the process of larger-scale updates to the course, and is one I do for exams, projects, quizzes, and recitations.

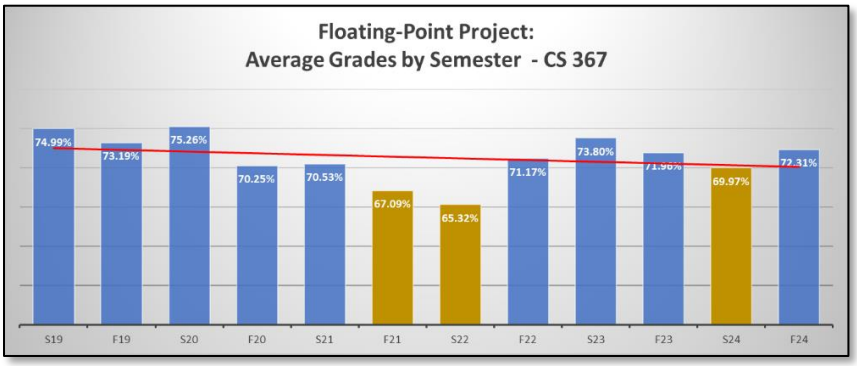

Figure 4: Project Metrics over Six Years

Looking at this assignment over time, though it does differ in its precise nature, it is a project that covers the same learning objectives by design (SLOs) and is done at the same difficulty of each component (ELOs), rendering it a stable source of assessments over time. This is the project to measure the floating-point SLO used demonstratively throughout this sample. This allows me confidence that the students are prepared for this material and, despite how any semester may feel, that the they are consistently meeting their objectives.

The final assessment is then made with respect to our accreditation Course Outcomes, which provides a final view of how the course has been improving, or early warnings of how it has been degrading, in the larger picture, semester by semester.

ABET Course Outcomes	Percentage			
	Strongly Met	Met	Weakly Met	Not Met
1. Demonstrate understanding of data representation at machine level, including binary numeric encodings, data structures, and Boolean operations.	66%	15% ↓	12% ↑	6%
2. Demonstrate understanding of program representation at the machine level using assembly language, including control flow, procedures, and file linking.	61% ↓	19% ↑	9%	11% ↑
3. Demonstrate practical techniques of system tools to understand low level behaviors of programs, including debuggers.	76% ↓	13%	5% ↑	5% ↓
4. Understanding of including basic CPU design including circuits, pipelining, and digital logic.	84% ↑ ↑	4% ↓ ↓	8% ↓ ↓	3% ↓ ↓
5. Demonstrate understanding memory concepts including virtual memory, caching, and dynamic memory layout.	66% ↑ ↑	13% ↓ ↓	12% ↑	9% ↓
6. Demonstrate understanding of computer processes, including its lifecycle and communications with the system.	55% ↑	27% ↑	8% ↓	10%
↑ (Green) indicates an increase over the prior semester. ↑ ↑ is a change of ≥ 5%				
↓ (Orange) indicates a decrease over the prior semester. ↓ ↓ is a change of ≥ 5%				

Figure 5: Faculty Course Assessment Report

Figure 5 shows a selection of my Faculty Course Assessment Report, which I annotate to show how the course has changed with respect to much larger objectives. Each Course Objective is comprised of dozens of SLOs that map into it. This provides a good assessment to me as to the efficacy of my changes from the prior semester.

Walking the Path with My Students

While not the most invigorating strategy, this is a small snapshot into what I owe to my students. They have committed to take a leap of faith in selecting this field, and in selecting me for this tiny subset of their education. They trust that I have sufficient knowledge to deliver the material, just as they trust that I am giving them an objectively complete and relevant course. They have all earned the right to be in this course, so it is incumbent on us to ensure that we are working to meet these expectations with an objectively sound and up to date selection of material.

Combined with periodic, direct student feedback, these techniques and metrics assist me in making the best strategic decisions about each course, in the best manner that I am able to deliver. These have helped me to achieve my primary goal in this position, which is to do all that I am able, in order to help the students to reach theirs.