

Fortifying asynchronous online learning with digitally delivered in-person assessments to leverage the testing effect

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Scan to visit website of UCF's Evaluation and Proficiency Center.

“Students know *far less* upon completing a course than faculty think they do.”

– NSF project assessing student achievement in undergraduate STEM courses

Why? What to do about it?

- What faculty think students get ≠ what students actually get
- Good exam scores ≠ conceptual understanding
- Effective assessment → student achievement ↑
- Formative assessment** monitors learning to give ongoing feedback
 - used by instructors to tune teaching
 - used by students to hone their learning
- “**Testing effect**” of quizzes vs. **low compliance/efficacy of homework**
- (Summative + Formative) assessments > **Summative only**
- Formative assessment + Peer Teaching → Student learning ↑

What is the testing effect?

- Students learn more when open-book study is augmented by frequent closed-book tests.
- At the Evaluation and Proficiency Center, timely, detailed feedback with opportunities for Socratic dialog locks in learning gains.

How do we assist students to develop STEM knowledge and skills when we digitize STEM content and assessments?

Digitizing STEM Content: Four Foci

- Core Concepts and Experiences** — Foundation of knowledge, examples, and varied experiences organized around big ideas
- Task Analysis** — Develop understanding sufficient for learners to prioritize key issues and sequence their solutions
- Metacognition** — Help learners gain awareness of their thinking processes, enabling adaptation to changing problems
- Engagement and Integrity of Learning** — Facilitated by course design and assessment delivery. UCF's Evaluation and Proficiency Center (EPC) approach emphasizes these from the ground up by combining digitally-delivered proctored testing with digital and F2F remediation

How can we improve student learning and faculty effectiveness in online and hybrid STEM courses through innovative pedagogies and by leveraging the testing effect?

Mixed-Mode LMS Layout
integrated Content, Evaluation, Tutoring, In-Class Problem Solving

10 modules of videos & slides

Remediation Hierarchy
Proficiency Center
Statistics, Content Guidance

2) Content Feedback
d) Von-Neumann Architectures and Com
If a more major jump start is needed, then t
<http://www.youtube.com/watch?v=HEJPop-q>

Bus Types: A specific feedback would be the number/role of the wires that compose them
<http://www.youtube.com/watch?v=4ISASg>

Control Bus
<http://www.youtube.com/watch?v=leWkVuz>

ing more comprehensive rec
<http://www.youtube.com/watch?v=leWkVuz>

8 study sets per module

4 problems at random per closed-book quiz

Figure 1. Hybrid STEM course with rich, interactive modules; study sets with worked examples; and dynamic test guides.

Score Clarification Improves Learning

Consider MIPS assembly code where the Byte address of label `start:` is 1024_{ten}.

```
start: lw $t0, 0($a0)
      addi $t0, $t0, 1
      test: bne $t0, $t1, start
```

Partial Credit 1: What is the Byte address of label `test:` in decimal?

Answer 1: 16384

Answer 2: 0x1528FFF8

Answer 3: 32

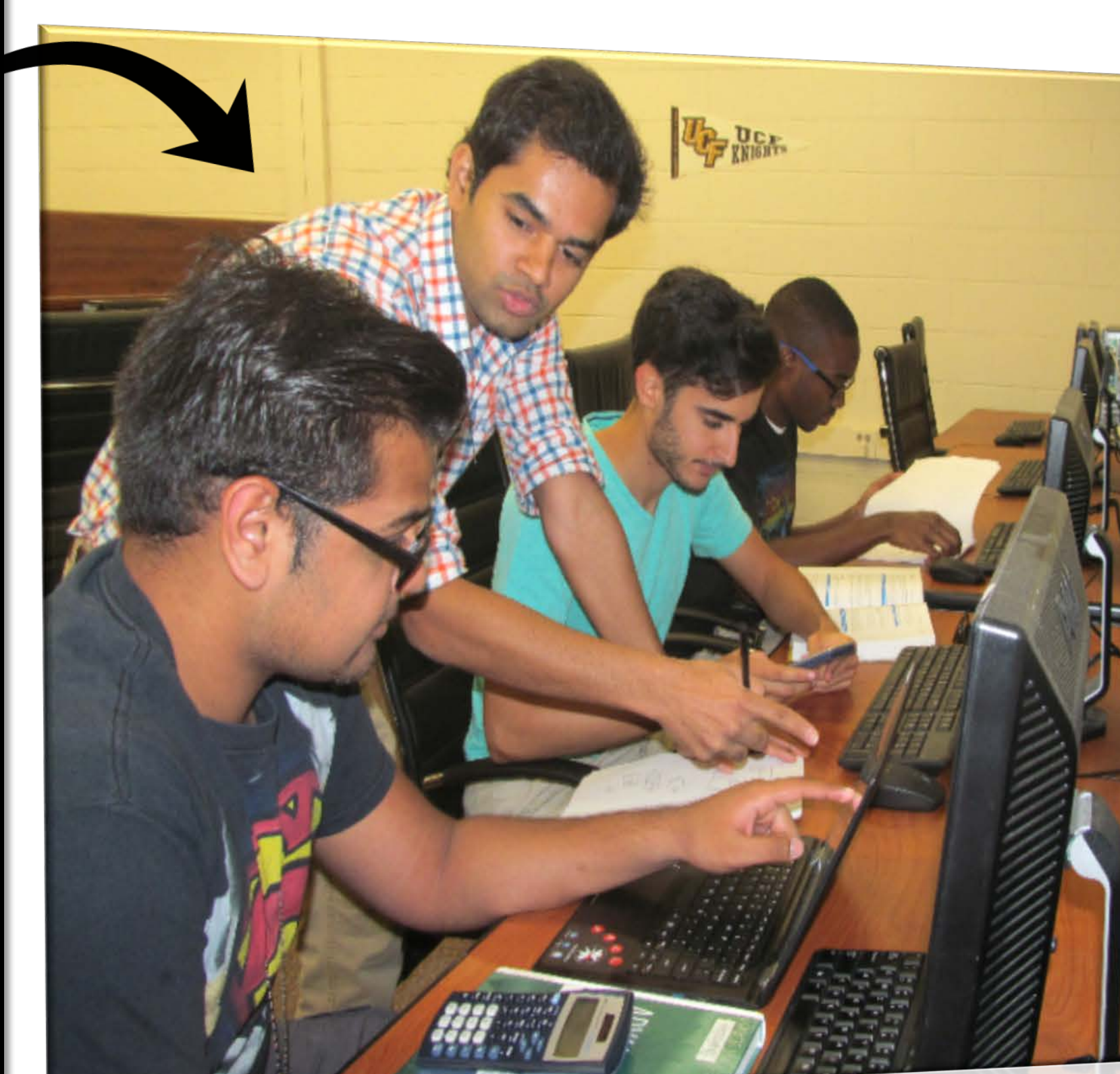
Answer 1: See Module on Instructions and Encodings. MIPS instructions are always 32-bits each. It is stated in fields that add to 32 on the Testing Reference Sheet. So, 32-bits is 4 Bytes per instruction. So, `lw` is at 1024, `addi` is at 1028, and `bne` is at 1032.

Answer 2: `bne` instructions are an I format instruction with opcode = 000101. The source register, `$t0`, is mapped to register 8 (01000), and the target register, `$t1`, is mapped to register 9 (01001), so the first 16 bits are encoded as 0001 0101 0000 1001. To find the value encoded in the branch location, we determine the start label is 2 instructions back from the branch instruction, but we have to subtract 1 more because the program counter is already incremented by 4 Bytes by the time the `bne` instruction is completed, so the value for the branch location is -3 (FFF8 in 2's complement hex). So the total instruction is 0001 0101 0000 1001 1111 1111 1101 which is 0x1509FFF8.

Figure 4. Score clarification explains why an answer was incorrect. Students can meet with tutors for further explanations and Socratic dialogs.

EPC Integrity Gains

- Test banks often get leaked online—non-proctored quizzes might easily be answered via Google.
- New ways to cheat are emerging all the time.



A tutor assists students at UCF's EPC during a practice exam and review session

Figure 2. The EPC is not just for proctored testing, but also open tutoring and exam prep. Tutoring, lab, and sign-in areas are separated from assessment areas to maintain quietness.

Question 1: 10 / 10 pts

Given: A lighthouse equipped with a laser ranger finds points its laser beam at a ship located 3 km away. Assume all overheads are ignored.

Partial Credit 1: What is the *roundtrip* propagation delay between the lighthouse and the ship?

a) 10 μsec
b) 12.5 μsec
c) 20 μsec
d) 25 μsec
e) 10 msec
f) 12.5 msec
g) 20 msec

Answer 1: c (Note: Indicate ONLY the LETTER corresponding to your choice)

Partial Credit 2: What is the *roundtrip* propagation delay expressed in picoseconds?

a) 10,000.00 psec
b) 12,500.000 psec
c) 20,000.000 psec
d) 10,000 psec
e) 12,500 psec
f) 20,000 psec
g) 25,000 psec
h) none of the choices listed

Answer 2: c (Note: Indicate ONLY the LETTER corresponding to your choice)

Partial Credit 3: What is the maximum number of distance measurements that can be performed in a millisecond?

a) 10
b) 12
c) 25
d) 40
e) 50
f) 53
g) none of the choices listed

Answer 3: e (Note: Indicate ONLY the LETTER corresponding to your choice)

Question 2: 5 / 5 pts

Based on the materials provided in class, which properties listed below are applied to answer the preceding question, i.e. Question 1? Indicate *all* which would apply:

time of flight principle **Correct!**

time of night principle

Flight of time principle

right of time principle

Propagation speed of light **Correct!**

diffraction coefficient of light

photoelectric effect

none of the choices listed

Question 3: 5 / 5 pts

Given: An athlete drank exactly 884.0 Liters of Gatorade over an interval of 2.0 years. Sought: How many milliliters of Gatorade did this athlete drink daily on average? Note: Express your answer to the nearest single decimal point, i.e. 0.1 mL.

1211.0 **Correct!**

Question 1: Digitization of engineering problem solving through decomposition into incremental assessments

Question 2: Digitization of conceptual understanding problems using multiple answer format to award partial credit automatically

Question 3: Formula question format

Clones are generated based on various versions of the problem's given statement

Scratch sheets are scanned-in to facilitate post assessment review during Score Clarification

Figure 3. Through digitized quizzes, faculty can use dynamic variables, partial credit, scripted feedback, and more. Proctored delivery prevents cheating and increases content acquisition via the testing effect. Faculty typically provide a 3-day window for students to schedule their quiz.

Table 1. STEM instructional methods strengths and weaknesses.

Delivery	Strengths	Weaknesses
Conventional	Status quo bias; some advantages for large class sizes	Lack of content engagement, potential for cheating, may not teach soft skills, lectures may inhibit learning
MOOC	High instructor productivity—can reach thousands of students; peer-assessment is feasible	No authentication, low retention, requires good Internet access, manual grading is difficult
Flipped or Blended Classrooms	Videos improve comprehension and student enjoyment; in-class time is reallocated to active learning and productive activities	Students may be unprepared or resistant, homework must be tailored to be effective, may lack instant feedback
Testing Center	Reduces cheating and allows scheduling flexibility; improves instructor and GSA productivity	Upfront equipment, software, and staffing costs; requires physical space and training
Evaluation and Proficiency Center (EPC)	Testing center, smart question design, score clarification, remediation, and open tutoring frees instructors' time and enables student success via integrity, engagement, and the testing effect	Challenging to implement—requires university- or department-level funding, changing existing instructor pedagogies, and cooperation from many stakeholders

Digitizing and Remediating STEM Assessments

University of Central Florida

Week	Modality	Topic	Date
0	Online Only	Course Preparation (read syllabus; intro discussion post)	–
1	F2F Class	BLUESHIFT & Course Walkthrough	Friday 5/26 at 1:00pm
2	F2F Class	Modularization & Immersive EPC Experience	Friday 6/02 at 1:00pm
3	Online Only	Exemplar Vignettes, Tutoring, and Score Clarification	–
4	F2F Class	Structuring Creativity/Design/Soft (CDS) questions	Friday 6/16 at 1:00pm
5	Online Only	UCF Support Resources	–
6	F2F Class	Showcase & Future Online Content	Friday 6/30 at 1:00pm

Table 2. Course schedule for Digitizing and Remediating STEM Assessments faculty workshop, Summer 2017. At UCF, we educate faculty from diverse STEM fields on how to digitize their assessments and integrate the EPC into their courses. As an incentive, we offer a course release.

Imagine not having to create new questions every semester, not having to administer exams, and having a support staff to explain grades to students. The EPC approach frees your time for teaching, research, and other high-impact work.