Developing Computer-Based Assessments for Large-Enrollment Classes: A Faculty Workshop for STEM Disciplines

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The design of effective digitization for formative and summative assessments that are suitable for computer-based exam delivery remains an open challenge across disciplines in science, technology, engineering and mathematics (STEM). The STEM-specific challenges include the need to adequately evaluate conceptual understanding, design skills, and solution structure that exceed the capabilities of rote multiple-choice formats. At the University of Central Florida, we have developed and evaluated a six-week cross-disciplinary Assessment Digitization Innovation (ADI) Workshop that supports STEM faculty in developing computer-based examinations. This case study evaluates the results of the workshop from the 2016 and 2017 cohorts. The evaluation results indicated a high level of satisfaction among participants with the ADI strategy and hands-on activities.

**ABSTRACT**

• STEM faculty predominantly use paper-pencil assessments (DeMara, Chen, Hartshorne, & Thripp, 2017)

• Potentials of computer-based assessments:
  • No significant differences in academic performance between CBA and paper-based assessment for equivalent STEM testing materials (Prisacari & Danielson, 2017)
  • More faculty time devoted to teaching and mentoring (DeMara et al., 2017)

• Benefits of testing effect in STEM education (Rawson, 2015): Mastery learning can be enabled for complex concepts through frequent formative assessments supported with timely and thorough feedback.

**CHALLENGES**

How do we prepare faculty to effectively facilitate and evaluate learning in large-enrollment STEM gateway courses?

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How do we prepare faculty to design and deliver online STEM-specific assessments?

• Conceptual Knowledge
• Procedural Application
• Creative Design

• Partial Credits Structure
• Question Data Banks

• Support Services
• Academic Integrity
ASSESSMENT DIGITIZATION INNOVATION (ADI) 
FACULTY WORKSHOP

Participants

• 2016 Summer Cohort
  • 10 faculty members, 3 TAs, ECE, CS, MAE, CECE, IEMS *
  • 10 undergraduate courses with over 6,000 annual student enrollment

• 2017 Summer Cohort
  • 7 faculty members, 2 TAs, ECE, CS, MAE, CECE
  • 7 undergraduate courses with over 2,500 annual student enrollment

• Asynchronous Participants
  • 2 faculty members, 1 TA, IT and ECE
  • 3 undergraduate courses with 1,500 annual student enrollment


Course Structure

<table>
<thead>
<tr>
<th>WEEK</th>
<th>MODALITY</th>
<th>TOPIC</th>
<th>ACTIVITIES</th>
<th>HOURS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Online</td>
<td>Course Start</td>
<td>Course orientation and introduction discussions</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>F2F</td>
<td>Flipping STEM Classes</td>
<td>Guest speakers and class discussions</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>F2F</td>
<td>Modularization Planning</td>
<td>Guest speakers &amp; a field trip to the Evaluation and Proficiency Center (EPC)</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Online</td>
<td>Exemplar Vignettes, Tutoring, and Score Clarification</td>
<td>Online readings and an assessment redesign plan</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>F2F</td>
<td>Structuring Creativity/Design/Soft Questions</td>
<td>Graduate student panel, guest speakers and optional open lab</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>Online</td>
<td>University Support Resources</td>
<td>Online readings and showcase preparation</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>F2F</td>
<td>Showcase &amp; Future Online Content</td>
<td>Participants showcase of their quizzes and study sets</td>
<td>14</td>
</tr>
</tbody>
</table>

HOW DID FACULTY PARTICIPANTS PERCEIVE THE BENEFITS OF THE WORKSHOP?

Faculty perceptions of benefits of ADI Workshop

- **Improved ability to serve large enrollments**: 92%
- **Convenience compared to traditional assessment delivery**: 92%
- **Time savings for faculty/GTAs**: 83%
- **Increased understanding of areas to remediate**: 83%
- **Increased learning outcomes**: 75%
- **Increased integrity of assessment delivery**: 75%
- **Honing of soft skills via Socratic clarifications**: 42%

n=12
Assessment strategies adopted by participants

- Use formative & summative tests to pace and scaffold student learning
  - Timely and thorough feedback
  - Learning analytics: quiz statistics
  - Variety of distractor choices
  - Question data banks: cloning procedures

- Use proctored tests with score clarification to enable mastery learning

- Replace lab reports with portfolio lab assessments to encourage student reflection and growth (Chen, DeMara, Salehi, & Hartshorne, 2018)

- Integrate various classroom active learning strategies to increase knowledge acquisition and critical thinking and problem-solving abilities

Adapting Canvas quizzes to present engineering questions

- Clone questions to form question data banks
- Use variables in formula and numerical answer questions
- Break problems into parts for scaffolding: using Design-by-selection, Matching, Multiple answers, etc.
- Provide detailed feedback

Faculty participants digitized one or more modules of their courses that potentially impact over 10,000 students annually