Infusing Universal Design for Learning (UDL) in Virtual Environments

Eleazar Vasquez & Matthew Marino
University of Central Florida
College of Community Innovation & Education
Toni Jennings Exceptional Education Institute
Acknowledgements

• The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education, through the Small Business Innovation Research (SBIR) program contract ED-IES-10-C-0023 to Filament Games and CFDA 84.295A. #U295A1025 to PBS. The opinions expressed are those of the authors and do not represent views of the Institute of the U.S. Department of Education.

• This material is based upon work supported by the National Science Foundation under Grants No. IIP-1046229, 1660018, 1913907, & 1949122. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.
Research goals at Toni Jennings Exceptional Education Institute (TJEEI)

• Development of innovative simulation-enhanced curricular materials.

• Establish cross-disciplinary partnerships to build and implement transformative curricula and assessments.

• Leverage the Universal Design for Learning (UDL) framework to enhance accessibility and executive function.

• Enhance STEM performance & persistence for ALL students.
Thank you partners!
Where students’ struggle

Executive Functions

Planning
Organization
Working Memory
Task Initiation
Set Shifting (flexibility)
Emotional Control
Impulse Control
Self-monitoring
The Universal Design for Learning Guidelines

Provide multiple means of Engagement
- Affective Networks
  - The "WHY" of Learning

Provide multiple means of Representation
- Recognition Networks
  - The "WHAT" of Learning

Provide multiple means of Action & Expression
- Strategic Networks
  - The "HOW" of Learning

Provide options for Recruiting Interest
- Optimize individual choice and autonomy (7.1)
- Optimize relevance, value, and authenticity (7.2)
- Minimize threats and distractions (7.3)

Provide options for Perception
- Offer ways of customizing the display of information (7.1)
- Offer alternatives for auditory information (7.2)
- Offer alternatives for visual information (7.3)

Provide options for Physical Action
- Vary the methods for response and navigation (4.1)
- Optimize access to tools and assistive technologies (4.2)

Provide options for Sustaining Effort & Persistence
- Heighten salience of goals and objectives (8.1)
- Vary demands and resources to optimize challenge (8.2)
- Foster collaboration and community (8.3)
- Increase mastery-oriented feedback (8.4)

Provide options for Language & Symbols
- Clarify vocabulary and symbols (2.1)
- Clarify syntax and structure (2.2)
- Support decoding of text, mathematical notation, and symbols (2.3)
- Promote understanding across languages (2.4)
- Illustrate through multiple media (2.5)

Provide options for Expression & Communication
- Use multiple media for communication (5.1)
- Use multiple tools for construction and composition (5.2)
- Build fluencies with graduated levels of support for practice and performance (5.3)

Provide options for Self Regulation
- Promote expectations and beliefs that optimize motivation (9.1)
- Facilitate personal coping skills and strategies (9.2)
- Develop self-assessment and reflection (9.3)

Provide options for Comprehension
- Activate or supply background knowledge (3.1)
- Highlight patterns, critical features, big ideas, and relationships (3.2)
- Guide information processing and visualization (3.3)
- Maximize transfer and generalization (3.4)

Provide options for Executive Functions
- Guide appropriate goal-setting (6.1)
- Support planning and strategy development (6.2)
- Facilitate managing information and resources (6.3)
- Enhance capacity for monitoring progress (6.4)

Expert learners who are...
- Purposeful & Motivated
- Resourceful & Knowledgeable
- Strategic & Goal-Directed
UDL instructional planning process

1. Establish clear outcomes
2. Anticipate learner variability
3. Measurable outcomes and assessment plan
4. Instructional experience
5. Reflection and new understandings

Learn more at...
http://udl-irn.org/
Iterative UDL classroom implementation cycle

- Clarify goals & performance expectations
- Class discussion of goals & objectives
- Anticipate Learner Variability
- Barrier analysis

- Provide EF scaffolds w/ flexible methods & materials
- Safety considerations
- Pathway choice & completion w/ continuous feedback
- Clarify assessment measurement plan

- Learning demonstration
- Reflect and revise pathway

Key
- Teacher Completes
- Student Completes
Teaching strategies to support executive function

- Build trusting relationships
- Active listening
- Mindfulness
- Cognitive reframing
- Direct and indirect questioning
- Prompting

- Patience / wait time
- Humor
- Accountability
- Positive reinforcement
- Growth mindset
Game-enhanced implementation cycle

1) Game Selection

2) Teacher Gameplay

3) Prepare Students

4) Team Gameplay

5) Debrief

6) Extension Activities

- Next Generation Science Standards
- Symbolic Representation
- Conceptual Understanding
- Procedural Knowledge
- Stem Related Social Skills
- Domain Specific Vocabulary
- Professional Development
- Technical Requirements
Link research-based strategies to UI features

Complex multi-step directions are presented using a series of easy to follow tasks that aid students with processing difficulties. Tasks are presented using text with a read aloud option.

Rich graphics provide students with multiple ways to view the same data. Teachers and IEP teams receive reports on player choice and performance. These reports can be easily exported.

“Sandbox” gameplay allows players to experiment with variables without high-stakes repercussions.

The player has a choice of analytical tools that they can use to meet their individual learning needs.

Players have access to narration for any and all text in the game.

Interactive learning environment motivates students by allowing them to customize the game based on their own preferences.

In-game experts provide modeling, tutorials and corrective feedback when students are unable to complete tasks independently.

Difficulty level adjusts dynamically based on player performance or teacher-specified proficiency levels. Students can track their progress toward benchmark objectives at any time.
<table>
<thead>
<tr>
<th>Pathogen Design Studio Features</th>
<th>UDL Check point</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide pictorial and verbal information about the intended host</td>
<td>5.1</td>
<td>Use multiple media for communication</td>
</tr>
<tr>
<td>Include well known pathogens and the ability to engineer new pathogens</td>
<td>5.2</td>
<td>Use multiple tools for construction and composition</td>
</tr>
<tr>
<td></td>
<td>5.3</td>
<td>Build fluencies with graduated levels of support for practice and performance</td>
</tr>
<tr>
<td>Structure the pathogen design process while allowing students to choose their own navigation path</td>
<td>6.1</td>
<td>Guide appropriate goal setting</td>
</tr>
<tr>
<td></td>
<td>6.3</td>
<td>Facilitate mapping information and resources</td>
</tr>
<tr>
<td>Offer &amp; track students’ use of an advanced tutorial to scaffold VLE navigation proficiency and reduce cognitive load</td>
<td>6.2</td>
<td>Support planning and strategy development</td>
</tr>
<tr>
<td></td>
<td>6.4</td>
<td>Enhance capacity for monitoring progress</td>
</tr>
</tbody>
</table>
What teachers told us

• All teachers reported their students were excited and motivated to play the game and participate in the research process.

• Teachers appreciated learning scaffolds in the game (i.e., highlighting vocabulary words, links to the pages in the textbook, and the visual dictionary).

• The games spurred unanticipated discussions about the content and scientific method, which led to increased learning by the entire class.
Consider the instructional supports in simulations

- Ability to personalize characters
- Clear goals and objectives
- Text-to-speech
- Virtual dictionary
- Expert modeling via a virtual mentor
- Extended learning and practice opportunities
- Immediate corrective feedback
- Advanced organizers to assist with planning and problem solving
- Collaborative grouping & peer tutoring options
- Iterative learning cycles ~ each level builds on and reiterates previously learned knowledge and skills
Media products

- 40 TV shows
- 16 digital games
- Science Power Notebook
- 8 Analog games
- 60 Hands-on Activities
- E-Books
Tablecraft

Freely available tablet/phone app.

- Mobile users will be able to join the virtual lab of any VR users using the same Wi-Fi network.
- Ability to interact, see statistics, make requests.
- VR users see the spectators, thus mitigating isolation.
Games address challenges with traditional assessment

• Print-based assessments measure decoding ability, writing ability, reading fluency, and reading comprehension before they measure subject-specific content knowledge.

• Students’ performance on print-based assessments can cause teachers to purport inaccurate inferences regarding students’ learning.

• Traditional assessments often focus on outcomes (e.g., # of terms recalled) without considering process.
# Earth Science Game Tracker: Sean Hilbert

## Games

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Game</th>
<th>Game Score</th>
<th>Time Played</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three Layers of Earth</td>
<td>36%</td>
<td>60%</td>
<td>Rockhound</td>
<td>85%</td>
<td>90 minutes</td>
</tr>
<tr>
<td>Minerals &amp; Rocks</td>
<td>42%</td>
<td>79%</td>
<td>Weather Wars</td>
<td>94%</td>
<td>90 minutes</td>
</tr>
<tr>
<td>Weathering, Erosion &amp; Soil</td>
<td>38%</td>
<td>68%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Atmosphere</td>
<td>40%</td>
<td>82%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecosystems</td>
<td></td>
<td></td>
<td>Eco-Lab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pollution &amp; Destruction</td>
<td></td>
<td></td>
<td>Polluter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Solar System</td>
<td></td>
<td></td>
<td>Solar Power</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earth &amp; its Moon</td>
<td></td>
<td></td>
<td>Tide Master</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[Dashboard Home Page](#)
Game Performance Report

Student Name: Sean Hilbert
Grade: 7
Game Title: Weather Wars
Project 2061 Benchmarks for Science Literacy: 48/M6 - 48/M9, 48/M11bc, 48/M12 - 48/M15

Game Mechanics Proficiency

Benchmark Performance

Key:
- First Attempt
- Second Attempt
- Third Attempt

Allows accurate interpretation of
# Advanced Report

Numbers correspond to the number of times the student accessed the tool. The minimum proficiency level can be adjusted by the teacher to meet the unique needs of each student.

<table>
<thead>
<tr>
<th>Digital Supports</th>
<th>M14 &amp; M15</th>
<th>M12 &amp; M13</th>
<th>M9 &amp; M11bc</th>
<th>M6-M8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert Avatar Accessed</td>
<td>0</td>
<td>Continuous</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Audible Task Prompts</td>
<td>Off</td>
<td>On</td>
<td>On</td>
<td>On</td>
</tr>
<tr>
<td>Audible Corrective Feedback</td>
<td>Off</td>
<td>On</td>
<td>On</td>
<td>On</td>
</tr>
<tr>
<td>Digital Camera Accessed</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Game Speed Adjustment</td>
<td>Advanced</td>
<td>Novice</td>
<td>Novice</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Visual Encyclopedia Accessed</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Visual Demonstration Viewed</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>RtI level</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Number of Attempts</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Proficiency Level</td>
<td>86%</td>
<td>80%</td>
<td>82%</td>
<td>84%</td>
</tr>
<tr>
<td>Time on Benchmark</td>
<td>8min 15sec</td>
<td>6min 20sec</td>
<td>10min 03sec</td>
<td>7min 46sec</td>
</tr>
</tbody>
</table>

**Overall Proficiency: 83%**
Student perceptions of VR game “Tablecraft”

How do you generally feel about science class?
- 55.6% like it. I enjoy learning about science in class.
- 30% I'd rather learn about science on my own, such as at home or online.
- 11.1% If I didn't have to study science, I probably wouldn't.

How much fun did you have playing Tablecraft?
- 0% I was bored the whole time!
- 1.1% 7.8%
- 24.4% I could play it forever!
- 33.3% 33.3%

Did you feel any motions sickness while playing?
- 93.3% Yes, I felt nauseous.
- Not at all.
- it is a little blurry in the VR
- Well, I personally am very sensitive to motion sickness.
- Not a lot though.
- just a little when I started and took it off.
- The VR machine made it kind of blurry.
- I felt a bit nauseous sometimes.
What students told us

• Students reported VR made learning about science more fun.

• They praised the ability to collaborate during the game and asked for more opportunities to collaborate physically and in virtual teams of 2 – 4 students.

• Students said they would rather play videogames and VR than take traditional paper and pencil tests.
What teachers told us about games & assessment

• Based on discussions with students, teachers reported the games **helped a majority of students**, especially students at the margins, **learn complex concepts and vocabulary**.

• The **paper and pencil test** was difficult for struggling readers and **was not an accurate indication of what students actually knew** about the content.

• **Gameplay statistics (user analytics)** might be a better indicator of students’ actual knowledge and skills.
Current challenges and future research

• Accessibility and adaptive user interfaces
• Instruction & assessment in virtual reality
• Haptics (e.g., vibrating gloves, suits, etc.)
• Internet of Things (opportunity vs. security)
• Multi-Modal data for advanced analytics
• Natural Language Processing to navigate and respond to simulated environments
Questions ~ Thank You!
Eleazar.Vasquez@ucf.edu
Matthew.marino@ucf.edu