MultiModal Learning

eXperiences & Learning Analytics

Annual meeting
Center for education & learning, Delft
12.12.22
The teaMM (virtualisation, MLX)

Bibeg  Nesse  Olivier  Jorge  Otte
Why MultiModal

Puts Context into the LA

- Meaningful interpretation of the learning process
- LA on steroids

Scientist: my discoveries are useless if taken out of context

Media:

Scientist claim their discoveries are useless
Beyond formal settings

Constrained learning settings

Sensors

Immersive feedback
Learning analytics for teachers
WEKIT: Wearable experiences for knowledge intensive training

Aircraft maintenance
Medical ultrasound
Astronaut training
WEKIT: **Expert-based** teaching methodology
Figure 3: The setups arrangement: Zoom (top-left), robot (top-right), HoloDisplay (bottom-left), HoloVR (bottom-right).
HoloLearn: Facilitating sync/async teaching
The **CaT**: The **Calligraphy Trainer**
Problem - Learning Handwriting

“More than 30% of girls and more than 50% of boys have problems acquiring fluid and legible handwriting” Marquardt et al., 2016

“Teachers often comment on a lack of time to complete the learning process” Bonneton-Botté et al., 2021
Goal

- Support teacher with close supervision of multiple students
- Enable teacher to provide highly custom and personalised learning content
Deliberate Practice

- **DP1** The teacher must define the task concretely with a clear goal and ensure that the student understands it.

- **DP2** The difficulty of the task must be barely above the students expertise level.

- **DP3** The practice task must be designed and performed in accordance with individualised instruction and guidance of a teacher.

- **DP4** The teacher should provide immediate informative and actionable feedback on each performance of the practice task which allows students to make appropriate adjustments to improve.

- **DP5** The students are able to “repeatedly perform the same or similar tasks.”
Background - Deliberate Practice Framework
Live Demo
Workshop Participation Overview

1. Brief overview of the datavis tool for Calligraphy Psychomotor skill Analytics

2. Visualization validation:
   - Each participant is presented a visualization with several questions
     - Fill in the MCQ answers based on ONLY the given visualization
     - Open text field for suggestions and feedback
Data vis VALIDATION

- Why validate?
  - Huge design space
  - Most designs ineffective
  - Teacher

- 4 nested design levels
- Focus on **idiom**
  - “How” to complete task
Exercise Report Analytics - Teacher Main Tasks

- **DP1:** Task defined concretely with clear goal, ensuring the student understands it
- **DP2:** Task difficulty barely above the students expertise

Teacher's two main tasks:
- *Does the student have problems?* → Find Biggest mistakes and identify the problem
  - **DP1 & DP2**
- *What is the student's motor skill level?* → Observe student's level of control for each handwriting parameter (speed, pressure, curvature, precision)
  - **DP2**
Exercise Report Analytics - Overview

<table>
<thead>
<tr>
<th>Feature</th>
<th>Big Errors</th>
<th>Correctness</th>
<th>Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>7</td>
<td>65%</td>
<td>None</td>
</tr>
<tr>
<td>Curvature</td>
<td>4</td>
<td>78%</td>
<td>Minor</td>
</tr>
<tr>
<td>Speed</td>
<td>21</td>
<td>72%</td>
<td>Good</td>
</tr>
<tr>
<td>Precision</td>
<td>2</td>
<td>86%</td>
<td>Minor</td>
</tr>
<tr>
<td>All Features</td>
<td>34</td>
<td>75%</td>
<td>Good</td>
</tr>
</tbody>
</table>

Click For Details
Exercise Report Analytics - Top Errors

General Overview Stats

<table>
<thead>
<tr>
<th>Features</th>
<th>Big Errors</th>
<th>Correctness</th>
<th>Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>7</td>
<td>65%</td>
<td>None</td>
</tr>
<tr>
<td>Curvature</td>
<td>4</td>
<td>78%</td>
<td>Minor</td>
</tr>
<tr>
<td>Speed</td>
<td>21</td>
<td>72%</td>
<td>Good</td>
</tr>
<tr>
<td>Precision</td>
<td>2</td>
<td>86%</td>
<td>Minor</td>
</tr>
<tr>
<td>All Features</td>
<td>34</td>
<td>75%</td>
<td>Good</td>
</tr>
</tbody>
</table>

Exercise Information

Student Name: __________
Exercise Name: Capital letter "A" 1
Exercise Description:
Trace over the capital letter "A" while focusing on tracing precision and producing straight stroke sections.
Repetitions: 12
Difficulty: 2/5

Error Location View:
Top Errors / Heatmap / Detail Inspector
Select Stroke(s): 1 2

Select view type
Top Errors
Heatmap

Graph of Error Progress over Repetitions for selected location(s)
1-Error
Rep(s)
Select Repetition(s)
Data Scope selection - Top Level Selection

Select Feature(s)
- Pressure
- Curvature
- Speed
- Precision
- All Features

Select Stroke(s) 1 2

Select view type
- Top Errors
- Heatmap

Select Repetition(s)
1 2 3 4 5 6 7 8 9 10 11 12

Reps
Exercise Report Analytics - Top Errors

General Overview Stats

<table>
<thead>
<tr>
<th>Select Features</th>
<th>Big Errors</th>
<th>Correctness</th>
<th>Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>7</td>
<td>65%</td>
<td>None</td>
</tr>
<tr>
<td>Curvature</td>
<td>4</td>
<td>78%</td>
<td>Minor</td>
</tr>
<tr>
<td>Speed</td>
<td>21</td>
<td>72%</td>
<td>Good</td>
</tr>
<tr>
<td>Precision</td>
<td>2</td>
<td>86%</td>
<td>Minor</td>
</tr>
<tr>
<td>All Features</td>
<td>34</td>
<td>75%</td>
<td>Good</td>
</tr>
</tbody>
</table>

Exercise Information

Student Name: ________________
Exercise Name: Capital letter “A” 1
Exercise Description:
Trace over the capital letter “A” while focusing on tracing precision and producing straight stroke sections.
Repetitions: 12
Difficulty: 2/5

Graph of Error Progress over Repetitions for selected location(s)

Select view type: Top Errors / Heatmap / Detail Inspector
Select Stroke(s): 1 2
Top Errors Controls: Top | Order by: Most occuring Errors, Least Progress Errors
Analytics - Select Error Icon

General Overview Stats

<table>
<thead>
<tr>
<th>Feature</th>
<th>Big Errors</th>
<th>Correctness</th>
<th>Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>7</td>
<td>65%</td>
<td>None</td>
</tr>
<tr>
<td>Curvature</td>
<td>4</td>
<td>78%</td>
<td>Minor</td>
</tr>
<tr>
<td>Speed</td>
<td>21</td>
<td>72%</td>
<td>Good</td>
</tr>
<tr>
<td>Precision</td>
<td>2</td>
<td>86%</td>
<td>Minor</td>
</tr>
<tr>
<td>All Features</td>
<td>34</td>
<td>75%</td>
<td>Good</td>
</tr>
</tbody>
</table>

Exercise Information

Student Name: 
Exercise Name: Capital letter "A" 1
Exercise Description: Trace over the capital letter "A" while focusing on tracing precision and producing straight stroke sections.
Repetitions: 12
Difficulty: 2/5

Error Location View:

- Top Errors
- Heatmap/Detail Inspector

Select Stroke(s)

Error Icon: OnClick:

update progress view

Graph of Error Progress over Repetitions for selected location(s)

1 Error

red markers indicate selected error occurrences

Reps

Select Repetition(s)
Analytics - Select Error Occurrence

General Overview Stats

<table>
<thead>
<tr>
<th>Feature</th>
<th>Big Errors</th>
<th>Correctness</th>
<th>Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>7</td>
<td>65%</td>
<td>None</td>
</tr>
<tr>
<td>Curvature</td>
<td>4</td>
<td>78%</td>
<td>Minor</td>
</tr>
<tr>
<td>Speed</td>
<td>21</td>
<td>72%</td>
<td>Good</td>
</tr>
<tr>
<td>Precision</td>
<td>2</td>
<td>86%</td>
<td>Minor</td>
</tr>
<tr>
<td>All Features</td>
<td>34</td>
<td>75%</td>
<td>Good</td>
</tr>
</tbody>
</table>

Exercise Information

Student Name: ___
Exercise Name: Capital letter "A" 1
Exercise Description:
Trace over the capital letter "A" while focussing on tracing precision and producing straight stroke sections.
Repetitions: 12
Difficulty: 2/5

Error Location View:
Top Errors / Heatmap [Detail Inspector]

Auto zoom to Error Location

Graph of Error Progress over Repetitions for selected location(s)

Select view type
Back to Top Errors

Too Fast  
Too Slow

Zoom and Pan Controls
Zoom [ ]  
Pan [ ]

Update Error location view to show Detail Inspector
Show single Rep in Detail Inspector
Select Repetition(s)
Workflow - "What went wrong?"

Top Errors Controls: 3, 5

Order by:
- Biggest Individual Errors
- Most occurring Errors
- Least Progress Errors

Error Icon

OnClick() 3

Big Error View

Highlight occurrences in progress view

Error Occurrence

OnClick()

Progress View

Switch Big Error View to Detail Psychomotor Skill Inspector

Detail Inspector View
Exercise Report Analytics - HWP Mastery

General Overview Stats

<table>
<thead>
<tr>
<th>Select Features</th>
<th>Big Errors</th>
<th>Correctness</th>
<th>Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>7</td>
<td>65%</td>
<td>None</td>
</tr>
<tr>
<td>Curvature</td>
<td>4</td>
<td>78%</td>
<td>Minor</td>
</tr>
<tr>
<td>Speed</td>
<td>21</td>
<td>72%</td>
<td>Good</td>
</tr>
<tr>
<td>Precision</td>
<td>2</td>
<td>86%</td>
<td>Minor</td>
</tr>
<tr>
<td>All Features</td>
<td>34</td>
<td>75%</td>
<td>Good</td>
</tr>
</tbody>
</table>

Exercise Information

Student Name: 
Exercise Name: Capital letter "A" 1
Exercise Description: Trace over the capital letter "A" while focusing on tracing precision and producing straight stroke sections.
Repetitions: 12
Difficulty: 2/5
Exercise Report Analytics - Big Error Icons

- Pressure: 5 occurrences big pressure error at icon location
- Curvature: 2 occurrences big speed error at icon location
- Speed
- Precision
Validation - Overview Stats

<table>
<thead>
<tr>
<th>Feature</th>
<th>Big Errors</th>
<th>Correctness</th>
<th>Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>7</td>
<td>65%</td>
<td>None</td>
</tr>
<tr>
<td>Curvature</td>
<td>4</td>
<td>78%</td>
<td>Minor</td>
</tr>
<tr>
<td>Speed</td>
<td>21</td>
<td>72%</td>
<td>Good</td>
</tr>
<tr>
<td>Precision</td>
<td>2</td>
<td>86%</td>
<td>Minor</td>
</tr>
<tr>
<td>All Features</td>
<td>34</td>
<td>75%</td>
<td>Good</td>
</tr>
</tbody>
</table>

- This vis helped me estimate:
  - The student’s biggest difficulties:
    - [ ] 1
    - [ ] 2
    - [ ] 3
    - [ ] 4
    - [ ] 5
  - Strongly disagree  ○ ○ ○ ○ ○ Strongly agree

- The student’s overall performance:
  - [ ] 1
  - [ ] 2
  - [ ] 3
  - [ ] 4
  - [ ] 5
  - Strongly disagree  ○ ○ ○ ○ ○ Strongly agree

- The following helped me answer the previous 2 questions:
  - The big error values
  - The correctness values
  - The progress values
  - The breakdown per feature
This vis helped me estimate:
- The student’s biggest difficulties:
  
- The student’s overall performance:
  
The following helped me answer the previous 2 questions:
- The selected stroke(s)
- The selected feature(s)
- The colors of the stroke(s)
- The locations of the red color on the stroke(s)
Validation - Big Errors (TOP 3)

- This vis helped me estimate:
  - The student’s biggest difficulties:
    - The selection (highlighted in green)
    - The icon’s numbers
    - The amount of icons
    - The icon colors
  - The student’s overall performance:
    - Strongly disagree: 0 0 0 0 0
    - Strongly agree

- The following helped me answer the previous 2 questions:
  - The selection (highlighted in green)
  - The icon’s numbers
  - The amount of icons
  - The icon colors
This vis helped me estimate:

- The student’s progress:

  The following helped me answer the previous 2 questions:
  - The selected error
  - The curves
  - The red dots
  - The selection (highlighted in green)
Validation - Detail Inspector

*big error occurrence has been selected*

- This vis helped me understand:
  - The student’s difficulties for the selected error:

- The following helped me answer the previous 2 questions:
  - The key (the meaning of the colors)
  - The color location
  - The color intensity
The likert questions
Thank you for listening!

Bibeg Limbu
b.h.limbu@tudelft.nl
KiteVR