Streamlined Technology-driven Orchestration

Lighton Phiri

Supervisors:
A/Prof. Hussein Suleman | Prof. Dr. Christoph Meinel
HPI-CS4A, University of Cape Town
We study technology-driven orchestration in order to understand the impact of organised orchestration of teaching.

- Study the use of an orchestration workbench for achieving streamlined technology-driven orchestration
- Demonstrate the successful use of approach
Formal learning spaces are inherently complex ecosystems—actors, activities, constraints.

Source: http://www.uct.ac.za
Motivation (2)

Formal learning spaces can be turned into effective learning environments by supporting educators with orchestration.

Source: http://www.uct.ac.za
Orchestration is challenging & ad hoc

Orchestration is *challenging* due to its multi-faceted nature
- Constraints such as time

Technology-driven orchestration is *ad hoc*—no standard way of orchestrating learning activities
- Analysis 1: Interviews
  - Expert reviews with eight UCT teaching staff
- Analysis 2: Observations
  - Classroom observations—END1020S; END1021F; STAT1100S
- Analysis 3: Archival records
  - UCT archived lecture recordings
Thesis statement

Streamlined orchestration—attainable through explicit organisation of learning activities using an orchestration workbench—could potentially make educators more effective.

Research questions

1) Does an orchestration workbench enable educators to become more effective?
2) What is the impact of an orchestration workbench on educators’ teaching experience?
Inspiration

We draw inspiration from the success of explicit organisation of tasks and activities in other domains; for instance IDEs have proved successful in software development.
Streamlined orchestration

Using the concept of cross-plane integration [1] we view orchestration as a function of the scale of learning activities—individual, group or class—with respect to time.

- Enactment of learning activities
- Sequencing of activities
- Learning activity management
- Centralised access to tools and services

Study 1: Ad hoc vs. organised orchestration

- **PortableApps used to simulate ad hoc orchestration**
- **Workbench UI used to simulate organised orchestration**
Study objectives

How does effectiveness & UX of organised orchestration, using an orchestration workbench, compare with ad hoc orchestration?

- H1: Workbench is more effective
- H2: Workbench results in positive user experience

<table>
<thead>
<tr>
<th>RQ</th>
<th>AH</th>
<th>Factor</th>
<th>Variable</th>
<th>Scale</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ1</td>
<td>H1</td>
<td>Task speed</td>
<td>$T_t$</td>
<td>Min</td>
<td>Task time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Success</td>
<td>PQ</td>
<td>[-3 – 3]</td>
<td>AttrakDiff 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Comfort</td>
<td>HQ-I</td>
<td>[-3 – 3]</td>
<td>AttrakDiff 2</td>
</tr>
<tr>
<td>RQ2</td>
<td>H2</td>
<td>UX</td>
<td>HQ-*;ATT</td>
<td>[-3 – 3]</td>
<td>AttrakDiff 2</td>
</tr>
</tbody>
</table>
Evaluation aspects

Effectiveness interpreted as follows:
- Learning activities orchestrated better, easier or faster
- Extent towards which orchestration goals were realised
- Participants’ level of comfort while orchestrating learning activities

User experience interpreted as participants' subjective views of orchestration technique's potential at meeting orchestration needs
Measurement instrument

AttrakDiff 2 used as primary measurement instrument

- Measures pragmatic quality (PQ), hedonic quality (HQ-I and HQ-S) and attractiveness quality (ATT) of interactive products
- Four dimensions associated with seven bipolar word-pairs—opposite adjectives

Comparison A-B

This type of study assesses each of the two different products separately and then compares them. You will be provided with an overview of how your customers perceive each of the products. You can decide whether both products are evaluated by the same test group, or whether product A and product B are evaluated by completely different test groups.

Source: http://attrakdiff.de
Study participants

At least 53 participants required for ‘two-sample student t-test’

> pwr.t.test(d = 0.55, sig.level = 0.05, power = 0.80, type = c("two.sample"))

Two-sample t test power calculation

  n = 52.87102
  d = 0.55
  sig.level = 0.05
  power = 0.8
  alternative = two.sided

NOTE: n is number in *each* group

29 participants recruited with varying levels of study, experience teaching and experience using computers
Experimental variables & conditions

- Within-subject experiment involving two experimental conditions
  - IV: orchestration technique
  - DV: time on tasks; AttrakDiff 2 dimensions
  - CV: ISP levels; Teaching experience; Computing experience
Experimental procedure (1)

Pre-task activities

Orchestration tasks

Post-task activities

- Study briefing and consent
- Demographic information
  - ISP level—year of study
  - Teaching experience
  - Computing experience
Experimental procedure (2)

- Random experimental blocks

<table>
<thead>
<tr>
<th>Participants</th>
<th>Approach 1</th>
<th>Approach 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group 1</strong></td>
<td>15</td>
<td><em>Workbench</em></td>
</tr>
<tr>
<td><strong>Group 2</strong></td>
<td>14</td>
<td><em>PortableApps</em></td>
</tr>
<tr>
<td></td>
<td><em>PortableApps</em></td>
<td><em>Workbench</em></td>
</tr>
</tbody>
</table>
Experimental procedure (3)

Pre-task activities

Orchestration tasks

Post-task activities

Source: http://thunderboltkids.co.za
Experimental procedure (3)

- **Pre-task activities**

- **Orchestration tasks**

- **Post-task activities**

- **Guided orchestration**
  - Directed sequencing of learning activities

- **Learning scenario**
  - Lesson 1.1—"What are fuels?"
  - (1) Lesson -> (2) Video -> (3) Activity -> (4) Investigation
Experimental procedure (4)

- AttrakDiff 2 ‘Comparison A–B’
  - Approaches—PortableApps & Workbench UI
  - (1) Approach #1 -> (2) Approach #2
- Debriefing
  - Study summary
On average, orchestration of learning activities was 14.7% faster using workbench.
Results 2: AttrakDiff 2 (1)

AttrakDiff 2 portfolio-presentation

- Both orchestration approaches fall within the same character region
- Workbench approach falls closer to desired character region
Results 2: AttrakDiff 2 (2)

AttrakDiff 2 dimension means

- **PQ; HQ-I; ATT**
  - Mean score higher for workbench on average
- **HQ-S**
  - Mean score slightly higher for PortableApps on average

Further analysis of dimension means done using word-pairs
Analysis 1: Counterbalancing

Potential impact of approach complexity during transition

<table>
<thead>
<tr>
<th></th>
<th>Workbench</th>
<th>PortableApps</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>5.14 (1.86)</td>
<td>7.00 (1.73)</td>
<td>Workbench 36.2% faster</td>
</tr>
<tr>
<td>Group 2</td>
<td>4.33 (2.12)</td>
<td>4.11 (1.05)</td>
<td>PortableApps 5.4% faster</td>
</tr>
</tbody>
</table>

Similar trends as overall results for dimension means

<table>
<thead>
<tr>
<th></th>
<th>Approach</th>
<th>PQ</th>
<th>HQ-I</th>
<th>HQ-S</th>
<th>ATT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>Workbench</td>
<td>0.33 (1.26)</td>
<td>0.45 (1.54)</td>
<td>0.36 (0.67)</td>
<td>0.33 (0.71)</td>
</tr>
<tr>
<td></td>
<td>PortableApps</td>
<td>0.19 (1.09)</td>
<td>0.17 (1.25)</td>
<td>0.57 (0.97)</td>
<td>0.17 (0.93)</td>
</tr>
<tr>
<td>Group 2</td>
<td>Workbench</td>
<td>1.59 (1.48)</td>
<td>2.10 (0.77)</td>
<td>0.90 (0.72)</td>
<td>0.95 (0.60)</td>
</tr>
<tr>
<td></td>
<td>PortableApps</td>
<td>0.89 (1.44)</td>
<td>1.19 (0.93)</td>
<td>1.71 (0.92)</td>
<td>1.37 (1.11)</td>
</tr>
</tbody>
</table>
Analysis 2: User comments

Participants’ comments

“If I were to do this with my learners I would definitely do approach 1” — Group 1

“Having to use approach 2 with my learners would take longer than doing the first one” — Group 1

“I liked it more than the first approach. This was really good and creative, easy to access your resources and activities” — Group 2

“The second activity was harder for me to do.” — Group 1
Study findings

Workbench approach potentially more effectiveness
● Learning activities orchestrated faster using workbench
● Perceived success more pronounced with workbench

Positive user experience for workbench approach
● Workbench had higher mean score for HQ-I and ATT dimensions
Study 2: Orchestrating a flipped class

CSC2002S—Computer Architecture flipped class outline structure

Source: https://youtu.be/x5s0aENwNMA
Study 2: Orchestrating a flipped class

CSC2002S—Computer Architecture flipped class outline structure

Source: https://youtu.be/x5s0aENwNMA
Study objectives (1)

Study aimed at assessing the feasible and potential of organised orchestration in authentic educational settings.

- To what extent does workbench approach aid orchestration?
- What is the potential impact of workbench approach on learning?

<table>
<thead>
<tr>
<th>RQ</th>
<th>Object</th>
<th>Instrument</th>
<th>Scale</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ1</td>
<td>Educator</td>
<td>Video segments</td>
<td>Min</td>
<td>App usage</td>
</tr>
<tr>
<td></td>
<td>Educator</td>
<td>Interviews</td>
<td>[-3 – 3]</td>
<td>Interviews</td>
</tr>
<tr>
<td>RQ2</td>
<td>Learners</td>
<td>Survey</td>
<td>[-3 – 3]</td>
<td>Questionnaire</td>
</tr>
</tbody>
</table>
Study objectives (2)

*Workbench UI implemented to orchestrate core activities*

Source: [http://media.uct.ac.za](http://media.uct.ac.za)
Evaluation procedure (1)

- Usage pattern analysis involved video analysis of lecture recordings—"Presentation View"
  - Opencast Matterhorn segmentation analysis
  - 11 sessions analysed
  - Orchestration tools and usage frequencies noted
Evaluation procedure (2)

- Educator interaction with workbench tool was evaluated two-fold
  - Informal interview sessions
  - Direct observations of tool use
Evaluation procedure (3)

(1) Usage

(2) Educator

(3) Learners

- Learner survey conducted on last day of class to elicit subjective experience
  ○ 71 participants recruited
  ○ Static sequencing, learning activity organisation, and specific prototype features
Analysis 1: Tool usage pattern

- Nine orchestration tools used during duration of course
  - Most tools used to render content
  - Specialised tools once-off tasks
- On average prototype used most of the time
  - Used 66.72% on average
  - Switching occurred an average of two times with noticeable time during switchover

<table>
<thead>
<tr>
<th>Tool</th>
<th>Freq.</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workbench</td>
<td>10</td>
<td>00:30:31</td>
</tr>
<tr>
<td>VideoGlide</td>
<td>8</td>
<td>00:07:56</td>
</tr>
<tr>
<td>Firefox</td>
<td>1</td>
<td>00:21:29</td>
</tr>
<tr>
<td>Impress</td>
<td>1</td>
<td>00:38:26</td>
</tr>
<tr>
<td>Evince</td>
<td>1</td>
<td>00:00:50</td>
</tr>
<tr>
<td>QtSpim</td>
<td>1</td>
<td>00:12:47</td>
</tr>
<tr>
<td>Robotic Arm</td>
<td>1</td>
<td>00:01:24</td>
</tr>
<tr>
<td>TextEditor</td>
<td>1</td>
<td>00:02:07</td>
</tr>
<tr>
<td>VirtualBox</td>
<td>1</td>
<td>00:00:58</td>
</tr>
</tbody>
</table>
Analysis 2: Learner experience

- Tool perceived to have helped organise activities
- Static sequencing (activity listing) found helpful
- Timer feature perceived useful
Study findings

Feasibility of organised orchestration

● Facilitated neutral flow of activities
● Results from learner survey indicate tool was impact neutral

Potential to facilitate improved learning outcomes

● Learner survey suggests orchestration workbench has the potential to positively impact learning experience
Future directions

1) Experiment: Guided orchestration for peer learning
   ○ Authentic learning environment
   ○ Measuring effectiveness, orchestration load and user experience

2) Experiment: Dynamic enactment of learning activities
   ○ Pre-session management
   ○ Measuring orchestration load and user experience

3) Analysis: Comprehensive analysis of UCT lecture recordings
   ○ Support for ad hoc orchestration claim

4) Experiment: Sharable orchestration OERs
   ○ Reusable and sharable orchestration appliances
Bibliography


Streamlined Technology-driven Orchestration

Lighton Phiri

Supervisors:
A/Prof. Hussein Suleman | Prof. Dr. Christoph Meinel
HPI-CS4A, University of Cape Town
Study 1 results: AttrakDiff word-pairs

PQ and HQ-I word-pair means
Study 1 results: AttrakDiff word-pairs

HQ-S and ATT word-pair means
Study 2 results: demographic learner responses (1)

Learner survey responses by demographic
Analysis 2: Demographic differences

● ISP levels
  ○
● Teaching experience
  ○
● Computing experience
  ○