No more LOGIN!

Which tools facilitate classroom orchestration?

schmountz

Pierre Dillenbourg
DUET - Dual Eye-Tracking
Pair programming experiment

Low gaze recurrence

P. Jermann, M.-A. Nüssli & P. Dillenbourg
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(grants #K-12K1-117909 and #PZ00P_126611)

High gaze recurrence

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Nüssli, Jermann & Mullins
A classroom needs some objects to write on and to work around. In our example of acceptable classrooms, the basic element could be a triangular desk designed to be used by a single student (Figure 3). The Desk is embedded under a thin layer of wood. The LED display is embedded in the desk and can be used to give twenty different functions, including a question, etc. The Desk is equipped with a tiny microphone array (SAM) and a localized sound detection. Optically, there are various ways of making the desk interactive. One possibility is to install a sensor in the desk feet. Another possibility is to use light sensors and ultrasonic sensors (SST). However, we envision that a future desk should include a reduced set of multi-purpose elements that enable the teaching of content here.

Connected desks form various types of configurations. Figure 5 shows a classroom configuration using 36 tables. Figure 6 shows how the same number of tables can be used to form a variety of individual and group tables for 4 or 6 students. Figure 6 shows two examples of larger configurations adapted to interactive discussions involving the entire class.

The embedded LED array on each desk can be used for a broad variety of purposes. Figure 7 shows various examples of these possible uses, illustrating both constructive and anticipatory design of interactions. One example of constructive design is to provide feedback about the ongoing conversations dynamically, highlighting the speaker around the table. This can be done, for instance, by displaying the name of who is speaking to all participants (Figure 7a) or identifying who speaks with whom.

Andrea Mazzei, Youri Marko, Tabea Koll
Gadgets that ‘work well’ = \textit{dbr} (5,20)

orchestration load = \textit{f} (design)
Vocational education: Dual system: Logistics assistants (warehouse)
The TinkerLamp

Guillaume Zufferey, Patrick Jermann
Bertrand Schneider, Aurelien Lucchi

\[ F(1,37) = 6.68, p < .05 \]
Contre points

Gerbeur

24 etage

20 etage

SB = 280 m²
SBST = 24m²

Diepte = 11%
Diepte = 20%

Voor en na de onderbouw
23% = 15%
28% = 19%

13 etage
No sign. effect in understanding

mean = 7.84 vs. mean = 7.43
\[ F(1,14) = .25; \quad p > .05 \]

No sign. effect in problem-solving

mean = 5.16 vs. mean = 5.15
\[ F(1,14)=.06, \quad p>.05 \]
“Manipulation temptation”!

<table>
<thead>
<tr>
<th>Group</th>
<th>Collaboration quality</th>
<th>Manipulation discussion</th>
<th>Reflection discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 6</td>
<td>1.4</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Group 5</td>
<td>1.6</td>
<td>1.25</td>
<td>1.25</td>
</tr>
<tr>
<td>Group 8</td>
<td>1.4</td>
<td>1.25</td>
<td>1.00</td>
</tr>
<tr>
<td>Group 1</td>
<td>1.4</td>
<td>1.75</td>
<td>1.75</td>
</tr>
</tbody>
</table>

Son DoLenh, Patrick Jermann
SIMULATE

- Run a simulation of the current layout.
- Ask the students to predict before running.
PAUSE CLASS

- Pause all the actions (simulation, building model, etc.) in the whole class
Post-test

Sign. effect in understanding

Sign. effect in problem-solving

<table>
<thead>
<tr>
<th>Measures</th>
<th>Warehouse study's conditions</th>
<th>Evaluation of TinkerLamp 2.0 conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Paper/pen</td>
<td>TinkerLamp 1.0</td>
</tr>
<tr>
<td></td>
<td>WithTinkerBoard</td>
<td>TinkerLamp 2.0</td>
</tr>
<tr>
<td></td>
<td>TinkerLamp 2.0</td>
<td>NoTinkerBoard</td>
</tr>
<tr>
<td>Understanding score</td>
<td>7.84(2.85)</td>
<td>7.43(2.82)</td>
</tr>
<tr>
<td></td>
<td>9.38(2.03)</td>
<td>10.31(1.70)</td>
</tr>
<tr>
<td>Problem-solving score</td>
<td>5.16(1.70)</td>
<td>5.15(1.78)</td>
</tr>
<tr>
<td></td>
<td>6.44(1.65)</td>
<td>6.59(1.53)</td>
</tr>
</tbody>
</table>
Merci DBR, but why does it work?
[Step 1] A simple notation…

Orchestration is the real-time management of multi-plane multi-layer activity graphs that maximize constraints satisfaction and minimize entropy.
Discovery learning (Gijlers & de Jong)

Sub-classes
[Step 1] An **integrated** learning scenario can be modeled as a **directed graph**:

- vertices are learning activities $a_i$ 
- edges represent dataflow 
- embedded on $\pi \times t$

\[ \pi \]

\[ \text{Time} \]

\[ \text{Class} \]
\[ \text{Group} \]
\[ \text{Individual} \]
**Question 1**

**Question:** In large city marathons, should drug testing be applied to participants that finish two hours after the winner?

**Answer:**
- Yes, because cheating should always be punished
- Yes, because any runner taking drugs damages her health
- No, because they run for themselves, not for rankings
- No, because people have also the right to smoke and to drink alcohol

**Enter your arguments:** I believe in individual freedom
Question 1:

Question: In large city marathons, should drug testing be applied to participants that finish two hours after the winner?

Answer:
- Yes, because cheating should always be punished
- Yes, because any runner taking drugs damages her health
- No, because they run for themselves, not for rankings
- No, because people have also the right to smoke and to drink alcohol

Enter your arguments:
We consider self-responsibility an important quality for sporters. Yet, it does not apply to participants getting prize or medals.
Question: In large city marathons, should drug testing be applied to participants that finish two hours after the winner?

Possible answers:
1) Yes, because cheating should always be punished
2) Yes, because any runner taking drugs damages her health
3) No, because they run for themselves, not for rankings
4) No, because people have also the right to smoke and to drink alcohol
Question 1: In large city marathons, should drug testing be applied to participants that finish two hours after the winner?

Your answer and synthesis of known arguments:

Reminder

Individual:
Your arguments:
None

Individual arguments of students:

- No one would ever make the effort to run a marathon without being on drugs. from Nilis
- Someone who is two hours late this time could be the winner next time and the run before; in addition, it does not exclude drug use from Frank
- For the people that are not relevant for the result lists, it’s their own responsibility if they risk damage to their health. Yet, still they are cheating the other clean runners. To require a test from every amateur (while probably almost all of them are clean) would setup a system of total control and non-trust. from Andreas
- Cheating should always be punished but in particular when it is useless. from Pierre
- Even though a person runs a marathon for herself, she should be in favor of banning the use of drugs and willingly take the test from Pantelis
- You should make sure that the winners do not use drugs. No need to test the losers who are rather running for themselves. from Armin
Pedagogical integration + Technological integration
Stable relationship: other classes, parents, director,…

Event specific relationship: museum guide, butcher,…

pedagogical + technological integration
[Step 2] How to package Alzheimer pills?
active substance (pharmaceutics)

excipients

dosage form

packaging

instructional design (learning theory)
[Step 2] Kernel activities are designed from learning theories while orchestration also covers other activities, less directly related to instructional design, but should nonetheless be technically integrated.
Debriefing activities
(designed but undetermined)
School Routines
(non designed, fill the time)

- 90% (54/60) done
- 82% discussed with supervisor
1) Implantez l'entrepôt dans le plan ci-dessous sur la figure ci-contre.

2) Reportez les valeurs des surfaces de stockage dans les cases prévues de la feuille du travail ci-contre.

Que pensez-vous du degré d'utilisation de cet entrepôt?

Comment pourriez-vous l'augmenter? Pourquoi est-ce important?

3) Simulez 36 minutes de travail avec 1 gérant, et reporter les valeurs dans les cases prévues ci-contre.

Combien faudrait-il de gérants pour sortir 100 palettes en 1 heure?

A votre avis, quel est le type de chariot le plus efficace dans cet entrepôt?
Extraneous events (unavoidable)

Sick / drop-out
Network failure
Eureka!
Fire
Crane

manyscripts.epfl.ch
[Step 2] Kernel activities are designed from learning theories while orchestration also covers other activities, less directly related to instructional design.

\[ \beta = 1 \text{ if } a_i = f \text{ (audience, objectives, learning theory) } \]
\( \alpha_i : (\pi, t, \beta, \text{input, output*}, \text{tools, resources, instructions, ...}) \)

IMS-LD
[Step 3] The activity graph must satisfy intrinsic as well as multiple extrinsic constraints

**Intrinsic constraints**
- Students’ profiles
- Domain epistemology
- How people learn
- Curriculum relevance

**Extrinsic constraints**
- Time budget (t)
- Time segmentation
- Resources
- Control
- Space
- Costs
- Producing grades
- Leaving traces
- Safety
- Teacher’s energy
- Teacher’s self-image
- School culture
- ....
Extrinsic constraints

- Time budget (t)
- Time segmentation
- Control
- Resources
- Space
- Costs
- Producing grades
- Leaving traces
- Safety
- Teacher’s energy
- Teacher’s self-image
- School culture
- ….
Extrinsic constraints

- Time budget (t)
- Time segmentation
- **Control**
- Resources
- Space
- Costs
- Producing grades
- Leaving traces
- Safety
- Teacher’s energy
- Teacher’s self-image
- School culture
- ....
[Step 4] The activity graph must be permanently adapted to learners’ behavior as well as to extrinsic constraints and events.
Flexibility?

Fiber = \( R(a_i \rightarrow a_j) \)

Strength = \( 1 - p(a_j | \neg a_i) \)

Elasticity = \( f(t_i, t_j) \)

time decay

Pre-requisite
students acquire in \( a_i \) skills they need for \( a_j \)

Advance organizer
\( a_i \) pre-activates cognitive structures for \( a_j \)

Didactic contract
\( a_i \) presents teacher’s expectations about \( a_j \)

Motivation
\( a_i \) motivates learners for \( a_j \)

Logistics
\( a_i \) sets up the environment for \( a_j \)

Dataflow
input \( (a_j) = f(output(a_i)) \)

Operators
input \( (a_{i+1}) = f(output(a_i)) \)

Aggregation
e.g. collect data for debriefing

Distribution
e.g. JIGSAW set up

Group formation
e.g. form heterogeneous pairs

Group rotation
e.g. reciprocal teaching

Feedback
input for \( a_{i+1} \) is teacher’s FB on \( a_i \)

e.g. level groups

Decision
[Step 5 / HCI] A ‘flexible workflow’ is a paradox that can be addressed by physical ‘handles’ on digital structures (cf. step 7).
[Step 6] Does the color of computers matter?
[Step 6] Orchestration is usability when the user is the classroom.

<table>
<thead>
<tr>
<th>Circle 1</th>
<th>Individual</th>
<th>Constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cognitive load, pre-requisites,...</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Circle 2</th>
<th>Group</th>
<th>Constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Interdependence, WYSIWIS,…</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Circle 3</th>
<th>Classroom</th>
<th>Constraints</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Cockpit</td>
<td>Discipline, time, energy, reporting,…</td>
</tr>
</tbody>
</table>

User

Hutchins
[Step 7] The graph expands on information layers: \( ag = \pi \times t \times 1 \)
1. Mesure d'angles

1) Fais simplement un trait passant par le point d'intersection un angle de 90°. Immédiatement, observe que l'angle est de 90°.
2) Reproduis la même procédure avec un angle de 60° et la somme des deux angles.

A + B

65° 125° 37°
30° 90° 89°
135° 195°
Augmented reality environment for the training of carpenters
it’s not just paper, it’s which type of paper (cards, sheets, shapes,...)

Sébastien Cuendet
[Step 7] An activity graph has 2 layers, physical & digital, which are connected by ‘handles’.
[Step 8] Information layers differ in terms of information persistency.

- Persistency
- Validity

Invalid info
Memory load
[Step 9] By making visible what would otherwise be invisible, buffers increase persistency of information.
Physics 101: Exercises Session

Problems are delicious
“While Waiting Productivity” LOSS : 62% ➞ 6%

H. Alavi, Olivier Guédat
Teacher’s cockpit

Action buffer

Reflection buffer
[Step 10] Orchestration requires managing massive flows of information.
[Step 10] Orchestration requires managing massive flows of information.

As it differs from information theory

An emitter is any object or actor in the classroom that display information.
A signal exists if a receiver perceives it
The beat = 1 Hz
The channels are audio, vision, touch and wires.
The bandwidth is determined by the receiver’s capacity (= teacher’s cognitive load).

\[ 22 \times 50 \times 3000 < \frac{10}{3} \]
Hard to grasp all this discrete information – need to use slow verbal encoding to handle working memory demands.
Same information as before, but now placed in its appropriate spatial context. Rapidly “graspable” without verbal encoding.
[Step 11] The classroom geometry ‘chunks’ for the teacher (to be developed)
[Step 12] Modeling a classroom as an information system (to be developed)

\[ \text{ag}^0 = f((C, S, T, X), \text{learning-theory}) \quad f = \text{instruction design} \]

\[ \text{ag}^t = f'(\text{ag}^{t-1}, C^{t-1}, (S), T, X) \quad | \quad H(S, C^t) < H(S, C^{t-1}) \quad f' = \text{orchestration} \]

Orchestration the real-time management of multi-plane multi-layer activity graphs that maximize constraints satisfaction and minimize entropy

\[ \text{ag} = (V, E) \]

\[ V = \{ a_i : (\pi, t, \beta, \text{instruction, ressources, \ldots}) \land \sum_{i=1}^{\mid V \mid} t(a_i) = T \} \]

\[ E = \{(a_i, a_j): (\text{fiber, operator, strength, elasticity}) \mid j > i, \} \]

\[ H(C^t(S)) = \sum_{i=1}^{\mid S \mid} \sum_{j=1}^{10} (H(s_i, c_j) \ast (t - \text{persistency}(c_j, l))) \quad | \quad c_j \in \{\text{activity, attention, understanding, \ldots}\} \]
Lantern
(A. Alavi)

WiTeach
(Z. Crivelli)
Design for Orchestration

1. Control
2. Visibility
3. Flexibility
4. Physicality
5. Minimalism
6. Do not target heroes
Summary

1. Graph
2. Bloominess
3. Constraints
4. Flexibility
5. Paradox
6. 3rd circle
7. Layers
8. Persistency
9. Buffers
10. Flows
11. Revelateur
12. Modeling

Orchestration does not replace learning theories. It is a necessary but not sufficient condition for scaling up.

There is a need for HCI in education.

Yes, we can.
Orchestration?

Piaget, Vygotsky & Al Capone
Natacha Ongeloofelijk, Guillaume Zufferey, Patrick Jerman, M.-A. Nüssli, Quentin Bonnard, Hamed Alavi, Sebastien Cuendet Andrea Mazzei, Khaled Bachour, Olivier Guedat, Flaviu Roman, Frédéric Kaplanj, Julia Fink

Daniel Schwartz, Miguel Nussbaum, Frank Fischer, Yannis Dimitriadis, Pierre Tchounikine.

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