Instructional Use of Multimodal Resources in Explanations During a Scientific Café

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1. THEORETICAL ORIENTATIONS
Multimodality at the heart of cognitive processes


Metaphor of the multi-channel message achieving a global meaning

- Nature of each ‘mode’ et affordances (Gibson, 1979, Gerwing & Allison, 2009)
- Matters of interdependency and redundancy (e. g. Bavelas, Beavin, Chovil, Lawrie, Wade, 1992, Goldin-Meadow, 2003)

Each mode may contribute to the 3 interactional goals of

- Coordinating the communication
- Displaying social affiliation
- Building semantic structures through the building of reference
  - primary referential construction (e. g. Chui, 2005)
Focus on students’ gestures playing a referential function

**Representational gestures**

- Provide *embodied images of the referent*
- Depict a concrete physical referent by *drawing* in space / *locating* parts of it or tracing its trajectory / *miming* actions (Colletta et al., 2010, Cosnier & Vaysse, 1997, Kendon, 2004, McNeill, 1992, Streeck, 2009)
- Or visual metaphors for *abstract concepts* (Calbris, 2011, Cienki & Muller, 2008, McNeill, 1992)
- Can be *sequentially* organized

**Pointing gestures**

- “a communicative bodily movement which projects a vector whose direction is determined, in the context, by the conceived spatial location, relative to the person performing the gesture, of a place or thing relevant to the current utterance” (Enfield, Kita, de Ruiter, 2007: 1724)
- Concrete / abstract
Varying the modes of representation for teaching-and-learning

Multimodality in teachers’ discourse: empirical studies

- Experienced teachers make a greater use of multimodal combinations (Neill & Caswell, 1993)


Interpretation

- A multimodal teaching discourse provides the students with multiple explanations of the same concepts through the use of diverse representations (Singer & Goldin-Meadow, 2005)
2. DATA & INSTRUCTIONAL CONTEXT
The ‘scientific café’ extracurricular activity (90-120 min)

- **Instructors**: volunteer, especially trained students aged 15-17
- **Audience**: students aged 12-14
- **At school**
- **International environmental education project about drinking water management (E.U., Mexico, France)**

**INTRODUCTION (10 min)**
- Game rules
- Main Question (MQ)
- First Individual Anonymous Vote
- Introduction to the 3 thematic phases

**THEMATIC PHASES (3 x 20 min)**
- **KQ (x3)**
  - reading and group discussion
  - individual vote
  - answer and explanation
- **OQ**
  - reading and group debate
  - group vote and class debate
  - individual vote and results displayed

**CONCLUSION (15 min)**
- Synthesis of class debates (3 OQ)
- **MQ**
  - reading and group debate
  - group vote and class debate
  - individual vote and results displayed
9. Among the following products, which requires the most water, pound for pound, for its production?

- A. Wheat
- B. Beef
- C. Rice
- D. Coffee
- E. Microchips
- F. Apples

### YOU TALK!

### Information Desk

<table>
<thead>
<tr>
<th>Product</th>
<th>Water footprint world average (litres/kg)</th>
<th>Water footprint USA (litres/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 kg of wheat</td>
<td>1334</td>
<td>849</td>
</tr>
<tr>
<td>1 kg of beef</td>
<td>15,497</td>
<td>13,193</td>
</tr>
<tr>
<td>1 kg of rice</td>
<td>2291</td>
<td>1275</td>
</tr>
<tr>
<td>1 kg of coffee</td>
<td><strong>17,373</strong></td>
<td>4864</td>
</tr>
<tr>
<td>1 kg of microchips</td>
<td></td>
<td>16,000</td>
</tr>
<tr>
<td>1 kg of apples</td>
<td></td>
<td>700</td>
</tr>
</tbody>
</table>

**Pound per pound, worldwide, coffee production uses on average the most water.**

The water footprint of a product varies between countries due to different production practices and local climates.

12. Which of these statements is true for people living in a shantytown in Manila (Philippines) without indoor plumbing?

A. They pay 10 times more than someone in Manila who has indoor plumbing.
B. They pay 4 times more than a middle-class resident of Manhattan.
C. They pay 4 times more than a very rich resident of Manhattan.
D. They pay $3.00 per cubic meter (in Kenosha, the price is $0.68/m3).
E. All of these statements are true.
F. None of these statements are true.

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icar

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YOUTALK!__
got water?
Q2: explanatory slide

All of these statements are true.

Relatively little information is available on the household budgets of the poorest people on the planet. Nevertheless, the studies that are available tend to show that:

- people living in shantytowns in the developing world buy their drinking water at the highest price in the world, from tank trucks and from street vendors

- in cities, there can be very sharp differences in prices depending on whether one is connected to local water networks or not

- drinking water in shantytowns costs even more than it does in the world’s richest countries, where people have greater access to local water networks.

- In general, once one is connected to local water networks, household users all pay the same price, regardless of whether they are rich or poor.

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Question</th>
<th>Time spent on the slide</th>
<th>Time of explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>USA</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cathy</td>
<td>Q1</td>
<td>1 min 26</td>
<td>50.1 sec</td>
</tr>
<tr>
<td></td>
<td>Q2</td>
<td>2 min 16</td>
<td>1 min 25</td>
</tr>
<tr>
<td>Marlene</td>
<td>Q1</td>
<td>1 min 46</td>
<td>45.6 sec</td>
</tr>
<tr>
<td></td>
<td>Q2</td>
<td>2 min 40.4</td>
<td>1 min 34.4</td>
</tr>
<tr>
<td>Iris</td>
<td>Q1</td>
<td>26 sec</td>
<td>26 sec</td>
</tr>
<tr>
<td></td>
<td>Q2</td>
<td>1 min 02</td>
<td>48.7 sec</td>
</tr>
<tr>
<td><strong>FRANCE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sylvie</td>
<td>Q1</td>
<td>2 min 53.4</td>
<td>44.8 sec</td>
</tr>
<tr>
<td></td>
<td>Q2</td>
<td>1 min 48</td>
<td>48.3 sec</td>
</tr>
<tr>
<td>Océane</td>
<td>Q1</td>
<td>1 min 30</td>
<td>1 min 01.6</td>
</tr>
<tr>
<td></td>
<td>Q2</td>
<td>2 min 24</td>
<td>1 min 30.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>18 min 12 sec</strong></td>
<td><strong>9 min 55.2 sec</strong></td>
</tr>
</tbody>
</table>
3. METHODOLOGY
Research questions

1. How do instructors use multimodal resources to mediate the concepts that they have to explain to the students?

2. What are the effects of the multimodal combinations that they use regarding the referential construction of the involved concepts and the information provided to the students?

3. Are there any major cross-individual differences or styles in their multimodal explanation performance that may have instructional effects across languages?
Analyzing instructors’ performance of mediation

◆ **Mediation**: explanatory discourse supplementing the ‘information desk’ slide in order to help the students understand the concepts

◆ **3 types of semiotic resources:**

1) Data written on the slide (text & table)
2) Speech: addition of wordings and verbal *mediation* of the slide content
3) Gestural behavior (using ELAN):
   - attention focus (gaze & head orientation)
   - representational gestures
   - pointing gestures

   Co-occurring with a mediating verbal sequence

◆ **Characterizing instructional explanatory practice as a multimodal performance combining a diversity of semiotic resources (case studies)**
### Classification of the 91 verbal sequences of *mediation*

<table>
<thead>
<tr>
<th>Type of mediating verbal element</th>
<th>Rewording (32)</th>
<th>Elucidation (23)</th>
<th>Addition (36)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition</strong></td>
<td>No new information.</td>
<td>Relating two pieces of information from the slide.</td>
<td>Providing new pieces of information that cannot be inferred from the slide.</td>
</tr>
<tr>
<td></td>
<td>Rephrasing the information presented on the slide in the instructor’s own words.</td>
<td>OR</td>
<td>An addition may consist of an example, justification, implication, etc. of a fact mentioned on the slide.</td>
</tr>
<tr>
<td><strong>Examples from explanations about Q2</strong> (appendix 3)</td>
<td><em>so the way they get their water is they have to buy it from er: tank trucks and street vendors</em></td>
<td><em>the reason that it’s more expensive is because they don’t have access to: like a network of: of plumbing</em> and <strong>su- and supplies like that</strong></td>
<td><em>like in kenosha it doesn’t matter if you’re richer or if you don’t have as much money you guys are all paying the same for your water</em></td>
</tr>
<tr>
<td><strong>Initial text provided visually</strong> (slide reproduced in appendix 4)</td>
<td><em>people living in shantytowns in the developing world buy their drinking water at the highest price in the world, from tank trucks and street vendors</em></td>
<td><em>in cities, there can be very sharp differences in prices depending on whether one is connected to local water networks or not</em></td>
<td><em>in general, once one is connected to local water networks, household users all pay the same price, regardless of whether they are rich or poor</em></td>
</tr>
</tbody>
</table>
4. RESULTS
Pattern of attention focus alternation: screen / students

Ex from the French data

Figure 2. Attention focus during monologue explanation - French instructors (ELAN screen captures)*.

*Color codes for figures 1 and 2:
- Focus directed to the students
- Focus directed to the screen
- Unstudied dialogue sequences
Gesture (pointing/representation) and attention focus

Ex of the French corpus

Figure 3. Correlation between the attention focus and the type of gesture – Cathy and Océane (ELAN screen captures)*.

*Color code for figure 3: Focus directed to the students
Case 1: Use of representational gestures facing the students
Case 1: Use of representational gestures facing the students

<table>
<thead>
<tr>
<th>Speech</th>
<th>Representational gesture</th>
<th>Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 <em>Because most of our: er: coffee beans</em></td>
<td>Two hands: - parallel in conduit metaphor &gt; <em>quite a big thing/quantity</em> - palms to herself &gt; <em>hers</em></td>
<td><img src="image1.png" alt="Picture 1" /></td>
</tr>
<tr>
<td>2 <em>and everything</em></td>
<td>Keeping the parallel hands of the conduit metaphor &gt; <em>thing/quantity</em> + abstract pointing on the right &gt; <em>another, different</em></td>
<td><img src="image2.png" alt="Picture 2" /></td>
</tr>
<tr>
<td>3 <em>are not grown in the us\ so then</em></td>
<td>Hands pointing down, with beats on ‘not’, ‘grown’ and ‘us’ &gt; <em>ground, land, here</em></td>
<td><img src="image3.png" alt="Picture 3" /></td>
</tr>
<tr>
<td>4 <em>the production em: as far as we would see it</em></td>
<td>Polysign mainly using the right hand - claw shape: <em>to take</em> - moving up: <em>to grow</em> - cyclic trajectory: <em>process</em> &gt; <em>to cultivate, to harvest</em></td>
<td><img src="image4.png" alt="Picture 4" /></td>
</tr>
<tr>
<td>5 <em>here</em></td>
<td>Two hands pointing down &gt; <em>this land, the usa</em> + on the right &gt; getting closer to the slide</td>
<td><img src="image5.png" alt="Picture 5" /></td>
</tr>
</tbody>
</table>
Case 2: Establishing bridges between a variety of semiotic modes
Case 2: Establishing bridges between a variety of semiotic modes

<table>
<thead>
<tr>
<th>Speech</th>
<th>Focus</th>
<th>Gesture</th>
<th>Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 <em>so that</em></td>
<td>Students</td>
<td>Representational, two-hand: abstract pointing to the right&gt; causality</td>
<td><img src="image1.png" alt="Picture" /></td>
</tr>
<tr>
<td>2 <em>might be why</em></td>
<td>Students</td>
<td>Hands’ trajectory transformed into a concrete pointing at the slide</td>
<td><img src="image2.png" alt="Picture" /></td>
</tr>
<tr>
<td>3 <em>ours is</em></td>
<td>Screen</td>
<td>Concrete pointing: right hand index finger pointing at the slide, as referring to a precise point on the screen</td>
<td><img src="image3.png" alt="Picture" /></td>
</tr>
<tr>
<td>4 <em>lower</em></td>
<td>Screen</td>
<td>Representational, right hand: - moving down: <em>smaller</em> - flat line shape: <em>level</em> &gt; <em>low level</em></td>
<td><img src="image4.png" alt="Picture" /></td>
</tr>
</tbody>
</table>
5. DISCUSSION
Model for a multimodal approach to explanatory practice in teaching settings

**SHOWING**
- Only and integrally reading the slide
- Attention focused on the screen
- No representational gestures

**TRANSMITTING**
- Verbal explanation without reusing words from the slide
- Attention focused on the students
- No pointing at the screen

**GUIDING**
- Verbal explanation reusing words from the slide as *anchors*
- Attention focus alternating pattern: screen/students
- Alternating representational and concrete pointing gestures

Both providing information and helping the students understand the written didactical resources

No link with the written didactical resources
Thank you for your attention!

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REFERENCES (1/2)

REFERENCES (2/2)

## Proportion of gesturing time in explanations

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Question</th>
<th>Pointing (%)</th>
<th>Representational gestures (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cathy</td>
<td>Q1</td>
<td>38,9</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Q2</td>
<td>29,7</td>
<td>30,1</td>
</tr>
<tr>
<td>Marlene</td>
<td>Q1</td>
<td>14,9</td>
<td>27,9</td>
</tr>
<tr>
<td></td>
<td>Q2</td>
<td>9,8</td>
<td>45,8</td>
</tr>
<tr>
<td>Iris</td>
<td>Q1</td>
<td>0</td>
<td>28,4</td>
</tr>
<tr>
<td></td>
<td>Q2</td>
<td>1,8</td>
<td>12,9</td>
</tr>
<tr>
<td>Sylvie</td>
<td>Q1</td>
<td>22,3</td>
<td>25,3</td>
</tr>
<tr>
<td></td>
<td>Q2</td>
<td>57,6</td>
<td>19,6</td>
</tr>
<tr>
<td>Océane</td>
<td>Q1</td>
<td>42,3</td>
<td>22,4</td>
</tr>
<tr>
<td></td>
<td>Q2</td>
<td>30,6</td>
<td>43,8</td>
</tr>
</tbody>
</table>