Metalanguage for Describing & Analyzing Multimodal Discourse of Science

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Science Multimodal Discourse

Scientific discourse consists of these semiotic modes (Van Rooy & Chan, 2017):

1. **Verbal-Linguistic**: words – vocabulary, grammar, genre level
2. **Visual-Graphical**: image, drawing, graph, animation
3. **Mathematical-Symbolic**: equation, scientific notation
4. **Gestural-Kinaesthetic**: gesture, bodily movement
5. **Material-Operational**: apparatus, demonstration, practical work

Multimodal: combined use of 2 or more of these modes to make meanings
Example in a Printed Text

Output voltage against time graph for a simple a.c. generator

At different positions, the rate at which the coil cuts across the magnetic field differs. Figure 22.6 shows how the magnitude of the output voltage (induced e.m.f.) changes as the coil rotates. Note that the alternating voltage in turn produces an alternating current (hence the name alternating current generator).

1. When the plane of the coil is parallel to the magnetic field, the arms AD and BC cut across the magnetic field lines at the greatest rate. Since the rate of change of magnetic flux is maximum, the magnitude of the induced e.m.f. is maximum.

2. When the plane of the coil is perpendicular to the magnetic field, the arms AD and BC do not cut across the magnetic field lines. Since the rate of change of the magnetic flux is zero, the magnitude of the induced e.m.f. is zero.

3. After the coil rotates half a cycle, it is parallel to the magnetic field again. The magnitude of the induced e.m.f. is maximum. Note that since the arms AD and CB are moving in directions opposite to those in step 1, the direction of the induced e.m.f. is opposite to that in step 1.

4. The arms AD and BC of the coil do not cut across the magnetic field lines. The magnitude of the induced e.m.f. is zero.

5. The coil has rotated one complete cycle. It is parallel to the magnetic field again and hence the maximum induced e.m.f. is produced.

*Figure 22.6* The induced e.m.f. varies with the position of the coil.
Metalanguage – What?/Why?

- Language for talking about language, images, texts, and meaning-making interactions (New London Group, 1996)
- “Meta-level” language: language to describe language (including representations)
- Metalanguage ≠ Meta-representation
- Useful to explicitly talk about the discourse practices and conventions in a discipline (Schleppegrell, 2013; Unsworth, 2008)
SFL/Social Semiotics:

• A set of (linguistic) metalanguage to describe the semantic functions and features of language use
Some Examples

**Verbal-linguistic analysis:**


Conjunction: e.g. when, since

Taxonomic: magnetic field (hyponym), arms AD & coil (meronym)


**Visual-graphical analysis:**

Narrative structure: vector

Conceptual structure: analytical process


Language use

Describes

Metalanguage"
Theoretical Tradition of Metalanguage (2)

Science Epistemology Studies:

- A set of (scientific) metalanguage to describe discourse practices among scientists
- Metalanguage are “terms for speaking about science, e.g., law, theory, claim, evidence, hypothesis” (Norris et al, 2008)
- “Second-level” language not usually used by people in their own discourse practices, but are useful to reflect on those practices (Shanahan, 2012)
- Include characteristics of scientific explanation & argument (Braaten & Windschitl, 2011; Osborne & Patterson, 2011)
## Examples of Metalanguage for Scientific Genres

<table>
<thead>
<tr>
<th>Experimental Account</th>
<th>Information Report</th>
<th>Explanation</th>
<th>Argument</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aim, method, procedure, independent &amp; dependent variable, hypothesis, result</td>
<td>Classification, composition, taxonomy, attribute</td>
<td>Principle, law, model, theory, concept, phenomenon</td>
<td>Claim, evidence, justification, warrant, rebuttal</td>
</tr>
</tbody>
</table>

Premise, Reasoning, Outcome – PRO  
(Tang, 2016; Putra & Tang, 2016; Rappa & Tang, 2018)
Metalanguage of Explanation – PRO

**Premise**
- Statement held to be true that does not need to be explained in the context of the explanation
- Provides a “first-cause” for an explanation

**Reasoning**
- Logical chain of sequences (cause-effect, temporal) that follows from the premises and links to the outcome

**Outcome**
- Phenomenon to be explained

Associated metalanguage terms:
- Principle, law, model, theory, concept, definition, postulate
- Cause-effect, sequence, deduction, conjunction
- Observation, phenomenon

Example of PRO

Premise (Principle)

Premise (boundary conditions)

Reasoning

Outcome

Spatial Reasoning

Continuous Outcomes

1. When the plane of the coil is parallel to the magnetic field, the arms AD and BC cut across the magnetic field lines at the greatest rate. Since the rate of change of magnetic flux is maximum, the magnitude of the induced e.m.f. is maximum.

2. When the plane of the coil is perpendicular to the magnetic field, the arms AD and BC do not cut across the magnetic field lines. Since the rate of change of the magnetic flux is zero, the magnitude of the induced e.m.f. is zero.

Fleming's right-hand rule

- force (thumb)
- magnetic field (forefinger)
- induced current (second finger)

• Applies to a.c. generators
Metalanguage for Combined Verbal-Visual Construction

Starting Postulates:

1. Many scientific genres cannot be realised through verbal language alone as they often involve images and other semiotic modes.
2. Scientific use of images are contextualized within a science genre to support the purpose of that genre.
3. There are some shared characteristics of images within a science genre.
# Scientific Images in Different Genres

<table>
<thead>
<tr>
<th>Experimental Account</th>
<th>Information Report</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spatial &amp; Macro Arrangements:</strong></td>
<td><strong>Classifying or Compositional Relationships:</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Argument</th>
</tr>
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<tbody>
<tr>
<td><strong>Dynamic &amp; Micro/abstract Processes:</strong></td>
<td><strong>Salience &amp; Modality:</strong></td>
</tr>
</tbody>
</table>

![Diagram 1](image1.png)

![Diagram 2](image2.png)

![Diagram 3](image3.png)

![Diagram 4](image4.png)
# A Metalanguage for Scientific Images

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Sub-categories and Relationships</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Association</strong></td>
<td>● Describes how 2 or more visual objects are joined together to each other</td>
<td>● Independent, connecting, adjoining, intersecting, inclusive</td>
</tr>
<tr>
<td><strong>Spatial</strong></td>
<td>● Describes how 2 or more visual objects are related to each other spatially</td>
<td>● Position, alignment, proximity, distribution, relative size/scale</td>
</tr>
<tr>
<td><strong>Movement</strong></td>
<td>● Describes how a visual object moves or acts dynamically</td>
<td>● Arrow, path line, wavy lines</td>
</tr>
<tr>
<td><strong>Perspective</strong></td>
<td>● Describes the point of view of how an object is depicted</td>
<td>● Dimension, angle, abstraction</td>
</tr>
<tr>
<td><strong>Modality</strong></td>
<td>● Describes the credibility of how an object is depicted</td>
<td>● Formality, simplicity</td>
</tr>
<tr>
<td><strong>Connective</strong></td>
<td>● Describes how smaller elements within a complex diagram are joined together to make logical connection</td>
<td>● Sequence, comparison</td>
</tr>
<tr>
<td><strong>Textual contextualisation</strong></td>
<td>● Describes the use of text to add or contextualize meanings to a visual object</td>
<td>● Label, legend, caption</td>
</tr>
</tbody>
</table>

Back to the first example...

MOVEMENT (Arrows)

CONNECTIVE (Temporal Sequence)

SPATIAL (Position & Alignment)

PERSPECTIVE (Oblique Angle)
Comparison of Images across Genres

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<th>Argument</th>
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<tbody>
<tr>
<td>Association</td>
<td>Association</td>
<td>Association</td>
<td>Association</td>
</tr>
<tr>
<td>(spatial connections)</td>
<td>(logical connections)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Movement</td>
<td>Movement</td>
<td><strong>Movement</strong></td>
<td>Movement</td>
</tr>
<tr>
<td>Perspective (macro)</td>
<td>Perspective</td>
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<td>Perspective</td>
</tr>
<tr>
<td></td>
<td>(micro/abstract)</td>
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<td>(comparison)</td>
<td>(sequence)</td>
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</table>
Conclusion

A *metalanguage is useful to describe*:  
(a) characteristics of multimodal representations as embedded within scientific genre  
(b) how visual representations are used correspondingly with verbal language of a genre

A *metalanguage is useful for*:  
(a) Researchers as an analytical toolkit  
(b) Teachers & students as a pedagogical toolkit

Goal: To discuss how multimodal discourse is used to produce & communicate scientific knowledge
Thank you!

Make tomorrow better.
Contact

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References


