Social Semiotics in Higher Education: Examples from teaching and learning in undergraduate physics.

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Quality, knowledge and creativity since 1477
Ångström Laboratory

Uppsala Physics Education Research Group
Department of Physics and Astronomy
Undergraduate teaching and learning in physics
In US 86 PER research groups
In university physics departments
In US 86 PER research groups
In university physics departments

Only one in Sweden
What is Physics Education Research?

A form of Discipline-based Education Research
Disicipline-based Education Research

“investigates learning and teaching in a discipline using a range of methods with deep grounding in the discipline’s priorities, worldview, knowledge and practices.

Long-term goal: “to understand the nature of expertise in a discipline”.

US National Research Council (2012, p 9)
Research group interests

Understanding physical phenomena
How do students understand physical phenomena and how can learning experiences be constructed to facilitate such understanding?

Social identity and the culture of physics
How does the culture of physics affect the possibilities for student learning?

Representation in physics
How can the different resources we use in physics be coordinated in order to improve the teaching and learning of physics?
# My personal interests

## The role of language
- Airey 2004; 2010; 2011a; 2012; 2015; in press
- Airey & Linder 2006; 2008
- Thøgersen & Airey 2011; Airey et al in press

## Disciplinary literacy
- Airey 2011b, 2011c; 2013; Linder et al 2014

## Representation in physics
- Airey & Linder 2009; Airey & Linder in press
- Ericsson et al 2014a; 2014b
- Fredlund et al 2012; 2015a; 2015b; 2015c

## Teacher identity/professionalism
- Larsson & Airey 2014a 2014b; 2015a; 2015b
- Airey & Larsson 2014
New research project

Four-year funding from Swedish Research Council
Benchmark physics teacher training across four countries with different PISA results

NIE, Singapore
Åbo Academy, Finland
Cambridge, UK
Uppsala, Sweden
New research project

Interested in the affordances and constraints for trainee physics teachers to construct a professional identity across different settings.
Social Semiotics in Higher Education: Examples from teaching and learning in undergraduate physics.

John Airey
What is social semiotics?

The study of the development and reproduction of specialized systems of meaning making in particular sections of society.

Airey & Linder (in press)

(See also descriptions in Halliday 1978; Hodge & Kress 1988; Thibault 1991; van Leeuwen 2005)

Use as a lens to understand teaching and learning in undergraduate physics.
Theoretical constructs

Learning a particular physics concept is dependent on becoming fluent in a critical constellation of semiotic resources.

(Airey 2009, Airey & Linder 2009)
Critical constellations

A Physics Concept

Airey & Linder (2009)
Theoretical constructs

*Discourse imitation* is when students use semiotic resources appropriately *without* the associated disciplinary understanding.

*Discourse imitation* occurs because students can’t become fluent in everything at once.

Teachers should expect discourse imitation

Airey (2009); Airey & Linder (2009)
Affordance

Key term in our work Affordance

(Gibson 1979; Norman 1988)
Two related affordances

Disciplinary affordance

*The agreed meaning making functions that a semiotic resource fulfils for a particular disciplinary community.*

Airey (2014)

Pedagogical affordance

*The aptness of a semiotic resource for teaching some particular educational content*

Airey (in press)
Disciplinary affordance

Disciplinary learning can be problematised in terms of *coming to appreciate the disciplinary affordances of semiotic resources*.

Fredlund *et al* (2012:658)

Focuses on the *discipline’s* interpretation of the resource rather than the learner’s experience.
Disciplinary affordance

The disciplinary affordance of a semiotic resource is shaped by its:

- Materiality
- Historical convention
- Rationalization

Airey (2014); Mavers
An example of a semiotic resource with high disciplinary affordance

*Information highly packed

*High level of usefulness in the discipline

Airey & Eriksson 2014
Pedagogical affordance

Deal with less information (reduces cognitive load)

Often less abstract

"(this is something you can ‘see’)"

Has limited use in the day-to-day work of the discipline
Life cycle of a massive star

- Red Supergiant
- Supernova
- Black hole
- Neutron Star
- Recycling
- Nebula
Two related affordances

Disciplinary affordance
*Usefulness doing the discipline*

Pedagogical affordance
*Usefulness for teaching the discipline*
Pedagogical vs disciplinary affordance

Disciplinary affordance

Pedagogical affordance
Disciplinary affordance

Appropriate disciplinary learning only possible when there is a *match* between:

• what a given semiotic resource affords to the student  
  *(Gibson 1988; Norman 1979)*

And

• *its disciplinary affordance*  
  *(i.e. what it affords for the discipline)*
How can we help students discern disciplinary affordances?

1. **Unpack** the disciplinary affordance (Fredlund et al 2014)

2. **Use variation theory** to draw the appropriate disciplinary affordance to students’ attention
   (Marton and Booth, 1997; Lo, 2012; Marton, 2015)
1. Unpacking disciplinary affordance

**RC-circuits**  
Fredlund et al (2014)

Channel 1:

Channel 2:
Unpacking disciplinary affordance

Channel 2

Channel 1
Unpacking disciplinary affordance
Table I (e) shows the oscilloscope indicating a square signal from the function generator on Channel 2, and a characteristic charging and discharging curve from the capacitor on Channel 1. The students could finally get on with their measurements.

<table>
<thead>
<tr>
<th>Description</th>
<th>Circuit connection</th>
<th>Image on the oscilloscope screen</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) The students’ first connection</td>
<td>![Diagram](OC1 FG OC2 R C OC1)</td>
<td>![Oscilloscope Image](OC1 FG OC2 R C OC1)</td>
</tr>
<tr>
<td>(b) The students’ simplified connection</td>
<td>![Diagram](OC1 FG OC2 R C OC1)</td>
<td>![Oscilloscope Image](OC1 FG OC2 R C OC1)</td>
</tr>
<tr>
<td>(c) The circuit after the TA’s first intervention</td>
<td>![Diagram](OC1 FG OC2 R C OC1)</td>
<td>![Oscilloscope Image](OC1 FG OC2 R C OC1)</td>
</tr>
<tr>
<td>(d) The same circuit after having increased the frequency</td>
<td>![Diagram](OC1 FG OC2 R C OC1)</td>
<td>![Oscilloscope Image](OC1 FG OC2 R C OC1)</td>
</tr>
<tr>
<td>(e) The circuit after the TA’s second intervention</td>
<td>![Diagram](OC1 FG OC2 R C OC1)</td>
<td>![Oscilloscope Image](OC1 FG OC2 R C OC1)</td>
</tr>
</tbody>
</table>
Unpacking

Unpacking a semiotic resource *increases* its *pedagogical affordance* but *decreases* its *disciplinary affordance*

Airey (2015)
2 Variation theory

Use *variation theory* to draw the appropriate disciplinary affordance to students attention
(Marton and Booth, 1997; Lo, 2012; Marton, 2015)

*We notice aspects that vary...*
Hold all aspects constant except for the aspect of you want students to notice
Patterns of variation

Suggest that we can leverage this with all the disciplinary specific semiotic resources we use.

Allows students to discern the disciplinary affordance
Patterns of variation

Identify disciplinary-relevant aspects

Select appropriate semiotic resources

Create systematic pattern of variation that allows students to notice the disciplinary affordances

Shown how this systematic variation could be applied to help students notice disciplinary affordances in Optics and Electrostatics

Fredlund (2015); Fredlund et al (2015b)
Thanks for listening!
References


Kryjevskaia M, Stetzer M R & Heron P R L (2012) Student understanding of wave behavior at a boundary: the relationships among wavelength, propagation speed, and frequency Am. J. Phys. 80339–47


