Perspective-based Inquiry Learning

Developing a practical and an effective teaching repertoire

Fred Janssen
Teaching repertoire development
Popper’s dream

I dreamt of one day founding a school in which young people could learn without boredom, and would be stimulated to pose problems and discuss them; a school in which no unwanted answers to unasked questions would have to be listened to; in which one did not study for the sake of passing examinations

(Popper, 1973, p. 41)
Positioning in relation to Healey’s framework

Problem Healey’s model

Separation content and process
Toolbox for Perspective-based Inquiry Learning
100-year research tradition

How to bring students’ learning processes closer to researchers’ practices?
Dewey (1916); Bruner (1962); Schwab (1963); for a recent downloadable review of reviews [70 pages]  
→ Janssen et al (2016)

• Over 1.7 million scientific publications
• Over 150 reviews in the last 10 years (for science education alone)
• 5 Handbooks in the last 10 years (for science education alone)
• Recurrent “innovation” in primary, secondary and higher education
Why is inquiry-based teaching important?

It promotes:

• Motivation for learning
• Active learning
• Deep understanding and flexible use of knowledge
• Learning how to think like … (learning a perspective: how to create and criticize knowledge in a domain?)
• Developing a multi-perspectival approach to complex problems
• Understanding the nature of inquiry
Important but not practical

How to implement inquiry-based teaching with:

• Limited time and resources
  (for design, enactment and reflection)

• Large groups of diverse students

• An overloaded curriculum (much to teach)
Recurrent findings

• **Effective** approaches of inquiry-based teaching are often considered as not practical

• **Practical** approaches of inquiry-based teaching are *often not effective*, like:
  • Incidental unguided discovery learning
  • Cookbook inquiry

→ A need for tools to develop a practical and effective repertoire for inquiry based teaching
Hints for a practical and generative solution

Incremental innovation by recombination and adaption of existing building blocks
(see for the power of modularity in teaching Janssen et al, 2015)
Inquiry + Regular Teaching = Inquiry Based Teaching

Building blocks of inquiry

- Complex Question → Perspective(-s) → Tentative answer(-s) → Critical Test/Discussion

Building blocks of regular teaching

- Explanation → Perspective(-s) → Simple Questions → Complex Questions
A practical toolkit for building a repertoire for perspective-based inquiry learning

Three tools
• Laddering tool for explicating your current teaching approach
  [part 1]

• Building block tool for converting regular teaching into multiple forms of perspective-based inquiry learning
  [part 2]

• Perspective tool explicating and teaching domain-specific ways of thinking (perspectives)
  [part 3]
Part 1

Laddering tool for explicating current teaching approach
Co-construction of goal system representations


1. **Select** a representative lesson
2. **What** do you regularly do (lesson segments)?
3. **Why** do you do it that way, why is that important?
4. **Evaluate** what goes well (white boxes)/where you like to improve (grey boxes)
Goal system Joyce

Why important?

What do you regularly do?
Part 2

Building block tool for converting regular teaching into multiple forms of inquiry-based teaching
Tool for converting regular teaching into inquiry based teaching

Innovation by recombination with only five building blocks

- Explanation
- Simple Questions
- Complex Question
- Tentative Answer(s)
- Critical Test/Discussion
Complex question first!

Criteria
- Understandable
- Creates a need to know for what you like to teach
Converting regular to inquiry based teaching: some options

- **Regular**: Explanation, Simple Questions, Complex Question
- **IQBT a**: Complex Question, Explanation, Complex Question
- **IQBT b**: Complex Question, Tentative Answer(s), Critical Test/Discussion
- **IQBT c**: Complex Question, Tentative Answer(s), Critical Test/Discussion, Explanation
Many more options

- In class 1 (end)
- Before class 2
- In class 2

Complex Question

Book and/or Online
Explanations
Tentative Answer(s)

Critical Test/Discussion
Explanation
Simple Questions
Complex Question

Adaptive support by omission
Explanations
Tentative Answer(s)

Adaptive support by omission
Explanation
Simple Questions
Complex Question

Critical Test/Discussion

Students can choose or develop a complex question

**Adaptive support by omission**
Consider everything you normally do as support for students to answer the complex question and provide this support only if needed.
## Overview of options with the five building blocks

<table>
<thead>
<tr>
<th>Nature of the complex questions</th>
<th>One perspectives</th>
<th>Two perspectives</th>
<th>Multiple perspectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope of complex questions</td>
<td>One class</td>
<td>Multiple classes</td>
<td>Whole course</td>
</tr>
<tr>
<td>How many complex questions?</td>
<td>One</td>
<td>Multiple</td>
<td>Personalized</td>
</tr>
<tr>
<td>Who designs the complex questions</td>
<td>Teacher</td>
<td>Teacher and student</td>
<td>Student</td>
</tr>
<tr>
<td>Relation lecture, seminar, practicals</td>
<td>Separate</td>
<td>Lecture and seminar integrated</td>
<td>Lectures, seminar practicals integrated</td>
</tr>
<tr>
<td>Adaptive support</td>
<td>None</td>
<td>Few learning routes</td>
<td>Personalized learning routes</td>
</tr>
<tr>
<td>Emphasis</td>
<td>Understanding and application of knowledge</td>
<td>+ Analyzing, evaluating and creating knowledge</td>
<td>+ Critical use of perspective(s)</td>
</tr>
</tbody>
</table>
Part 3

Perspective tool for explicating and teaching domain-specific ways of thinking (perspectives)
Knowledge (growth) is perspectival
exemplified by the blind men and the elephant (poem from John Godfrey Saxe)

It was six men of Indostan
To learning much inclined,
Who went to see the Elephant
(Though all of them were blind),
That each by observation
Might satisfy his mind.

The First approached the Elephant,
And happening to fall
Against his broad and sturdy side,
At once began to bawl:
“God bless me! but the Elephant
Is very like a wall!”

The Second, feeling of the tusk,
Cried, “Ho! what have we here
So very round and smooth and sharp?
To me ’tis mighty clear
This wonder of an Elephant
Is very like a spear!”

The Third approached the animal,
And happening to take
The squirming trunk within his hands,
Thus boldly up and spake:
“I see,” quoth he, “the Elephant
Is very like a snake!”

The Fourth reached out an eager hand,
And felt about the knee.
“What most this wondrous beast is like
Is mighty plain,” quoth he;
“’Tis clear enough the Elephant
Is very like a tree!”

The Fifth, who chanced to touch the ear,
Said: “E’en the blindest man
Can tell what this resembles most;
Deny the fact who can
This marvel of an Elephant
Is very like a fan!”

The Sixth no sooner had begun
About the beast to grope,
Than, seizing on the swinging tail
That fell within his scope,
“I see,” quoth he, “the Elephant
Is very like a rope!”

And so these men of Indostan
Disputed loud and long,
Each in his own opinion
Exceeding stiff and strong,
Though each was partly in the right,
And all were in the wrong!
For many more examples of perspectives for multiple subjects ranging from mathematics, to history, to linguistics see free download Janssen et al, 2018
Perspectives scaffold and organize knowledge growth in a domain
Again: Why legs not wheels?

[Use the evolutionary perspective below. Try to come up with a least three different arguments]
Stepwise expanding the perspective driven by complex questions providing the need or expansion
Why Did Penguins Stop Flying?

Why Worker Bees Don't Have Babies

How Do Darwin's Finches Change Their Beak Sizes So Quickly?

Evolution by natural selection

Which functional item?
Current functional(-ies)?
Historical functional(-ies)?

Is there a continuous series of stages connecting the current item to a state with no item at all?

In which each stage can occur by heritable variation?

Structural genes?

In which each stage contributes better to reproductive success in the ancestral environment than existing alternatives?

Genetic?

Epigenetic?
Ecological?

Regulatory genes?

Change in time? (heterochrony)
Change in amount? (heterometry)
Change in location? (heterotopy)
Change in kind? (heterotypy)

Own reproductive success?
Reproductive success of relatives?
Perspectives are essential domain specific tools for thinking and provide coherence. What happens if they are skipped?

- Fragmentation
- Students lack powerful thinking tools to develop knowledge
- Students do not learn how to think like ….
The properties of substances can be explained by the nature of the particles of which it consists, the forces between them, and the movement and organization of those particles.
Biomedical perspective

How does a disease originate and how can it be treated?

• What are the complaints/ symptoms?
• How often, where and with whom does it occur?
• How does it normally function?

• What is going wrong?
  o Psychosocially
  o Physical damage
  o Pathogens
  o Auto-immune responses
  o Genetics
  o Nutrient deficiency

• How can it be treated?
• How can it be prevented?
Huidkanker (epidemie)

- Wat zijn de klachten/symptomen?
- Welke vormen zijn er?
- Hoe verloopt het ziektebeeld?
- Hoe vaak komt het voor?
- Is er verschil tussen man/ vrouw?
- Is er verschil tussen leeftijdsgroep?
- Is er verschil tussen mensens met bepaalde huidskleur?
- Wat gaat er mis?
- Hoe worden de normale functies van de huid vervuld?
- Hoe beschermt de huid tegen de zon?
- Hoe wordt vitamin D aangemaakt?
- Hoe wordt pigment geproduceerd?
- Waarom zijn er huidskleur verschillen?
- Hoe wordt huidkanker veroorzaakt?
  - Psychosociaal?
  - Fysieke schade?
  - Ziekteverwekkers?
  - Voedsel tekorten?
  - Autoimmuun?
  - Erfelijkheid?
- Hoe worden de normale functies van de huid vervuld?
- Hoe wordt pigment geproduceerd?
- Wat is de rol van anti-zonnebrand?
- Wat is de rol van zonnebank gebruiken?
- Wat gebeurt er in de cel?
- Zijn er opruimmechanismen?
- Zijn er herstelmechanismen?
- Treden er genetische veranderingen op?
- Hoe detecteer je dit?
- Zijn er genetische testen?
- Zijn er voorloper stadia?
- Is er in te zetten op preventie?
- Hoe detecteer je dit?
- Is een bruine tint gezond?
- Hoe worden de normale functies van de huid vervuld?
- Hoe wordt pigment geproduceerd?
- Wat is de rol van anti-zonnebrand?
- Wat is de rol van zonnebank gebruiken?
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Vraag 1: Hoe wordt huidkanker veroorzaakt?
- Team based learning 1: Huidkankerepidemie het probleem
- Team based learning 2: Hoe wordt huidkanker veroorzaakt

Vraag 2: Hoe wordt huidkanker behandeld?

Vraag 3: Hoe wordt huidkanker behandeld?

Vraag 4: Hoe wordt huidkanker behandeld?

Vraag 5: Hoe wordt huidkanker behandeld?

Vraag 6: Hoe wordt huidkanker behandeld?

Vraag 7: Team based learning 3: Hoe wordt huidkanker behandeld

Hoe kunnen preventieve maatregelen worden geïmplementeerd?
Some examples of perspectives from Leiden University

Perspective for European Law

*How to arrange free selling and buying for businesses and consumers in the EU?*

- How to prevent that EU member states obstruct free movement of production factors?
  - Goods?
  - Services?
  - People (citizens and labor)?
  - Capital?

- How to prevent that businesses complicate buying and selling?
Perspective for European Law
Sjef Barbiers

Taal mentaal 1: van zinsontleeder naar taalkundig onderzoeker

Taalkundig perspectief

Bouwstenen (8 niveaus)

Voor elke bouwsteen:
Welke eigenschappen?
Wat is de interne structuur? Wat is de externe distributie?
Welke combinatorische regels?
Rol van betekenis?
Semantische en syntactische selectie? Sonoriteit?
Betekenisdragend? Betekenisonderscheidend?
Compositioneel?
Diagnostiek?
Permutatie – Weglating – Vervanging – Integriteit – Hiërarchietesten (c-commandeerrelaties)

FGW

Grote vraag als startpunt voor elk hoofdstuk/college

- Hoofdstuk 1: Het Nederlands als cognitief systeem
  Vraag: Welke vragen kun je stellen over taal?

- Hoofdstuk 2: Bouwstenen van het Nederlands
  Vraag: Deel de volgende zin […] op in steeds kleinere onderdelen.

- Hoofdstuk 3: Een Nederlandse zin bouwen
  Vraag: Bouw met de bouwstenen uit hoofdstuk 2 een zin. Kan je de bouwstenen ook rijgen i.p.v. Mergen?

- Hoofdstuk 4: De ruggengraat van de Nederlandse zin
  Vraag: Waarmee begint het bouwen van een zin? Waarom?
Docenten moleculaire genetica (4 studieonderdelen in de bachelor)
Four bachelor courses of molecular genetics

- Molecular Biology 1
- Molecular Biology 2
- Molecular Genetics
- Genomics and Omics
Molecular genetic perspective
Perspectives for building portfolios

- Mathematical (basic) perspective
- Statistical perspective
- Ethical perspective
How to explicate a perspective?

If multiple teachers are assigned to a course the procedure below can be used to develop a coordinated team perspective or set of perspectives

**Step 1. List all concepts / insights that you like to teach**

For instance if you teach immunology.

adaptive immune system; B-cells; T-cells; complement; phagocyt; clonal selection, skin et cetera
Step 2: Organize concepts in groups (preferably in a hierarchy)
Step 3: Formulate related questions and organize them in a question agenda
Partial course overview (1,2,3 and 4 are numbers of lectures)

1. Complex question A
2. Complex question B
3. Complex question C
4. Complex question D
Fred Janssen

- Master’s degree in Biology
- PhD ‘Learning biology by designing’
- ICLON, Leiden Graduate School for Teaching (since 1999)
  - Biology teacher educator (until 2016)
  - Full professor of science education (since 2016)
  - Department head secondary education (since 2018)
  - Senior Comenius Fellow / Leiden Teachers’ Academy fellow
- Scientific director ICLON (since 2022)
- Focus of my own research program (13 PhD’s / 2 Post-docs)

An ecological approach to student and teacher learning
Interfacultair Centrum voor Lerarenopleiding, Onderwijsonderzoek en Nascholing (ICLON)

100+ onderwijsexperts

<table>
<thead>
<tr>
<th>Opleiden van academische docenten</th>
<th>Professionaliseren en wetenschapsoriëntatie</th>
<th>Onderzoek naar onderwijs</th>
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</thead>
<tbody>
<tr>
<td>• 1e graads &amp; 2e graads (meerdere trajecten)</td>
<td>• Wetenschapsoriëntatie PO</td>
<td>• 3 Hoogleraren</td>
</tr>
<tr>
<td>• 330 studenten</td>
<td>• Wetenschapsoriëntatie VO</td>
<td>• 2 UHD’s / 5 UD’s</td>
</tr>
<tr>
<td>• Vakdidactici alfa, bèta, gamma &amp; onderwijskundigen</td>
<td>• VO-HO aansluiting</td>
<td>• 45 lopende PhD projecten / 55 gerealiseerde dissertaties</td>
</tr>
<tr>
<td>• 18 schoolvakken</td>
<td>• ONZ netwerk &gt; 60 scholen i.s.m. de faculteiten</td>
<td>• 240 wetenschappelijke publicaties / 102 professionele publicaties (in de laatste 5 jaar)</td>
</tr>
<tr>
<td>• Samen opleiden met 9 opleidingsscholen waarbij 90% van alle VO scholen in de regio Zuid Holland zijn aangesloten</td>
<td>• Docentprofessionalisering (PO, VO, HO)</td>
<td>• Structurele samenwerkingsverbanden en publiceren met met 7 universiteiten uit de top 50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Nieuwe taak: coördinatie en versterking HO onderzoek</td>
</tr>
</tbody>
</table>

• Goede universitaire, regionale, nationale en internationale verankering
• Opleiden, professionaliseren en onderzoek m.b.t. de gehele keten (po, vo, ho)
• Uitstekende beoordelingen van visitatiecommissies
• Werken vanuit een gemeenschappelijke kennisbasis
ICLON Knowledge base

12 Teaching - Learning principles

For understanding and supporting student and teacher agency development
Selected publications


