How to measure Expressed Pedagogical Content Knowledge in real-time interaction

Carla Geveke, Henderien Steenbeek, Jeannette Doornenbal, Paul van Geert
Outline

› What is PCK?
› Aim of the pilot study?
› EPCK as a dynamic and embedded construct
› Research questions
› Method: case study, factor analysis, cluster analysis
› Results: instrument, factor analysis, cluster analysis
› Discussion
PCK: "Ways of representing and formulating the subject [content] that make it comprehensible to others" (Shulman, 1986)

Aim of pilot study: Build and test an instrument to observe how PCK is expressed and develops through real-time interaction (EPCK)
EPCK: embodied construct

> PCK is an indicator of the quality of the teacher: internal PCK – **expressed PCK (EPCK)**
> PCK develops in action- influencing the here-and-now
> PCK is embedded knowledge
> PCK is co-constructed by pupil and teacher
> PCK development is an iterative process
EPCK related to teaching quality

> Teacher’s **open teaching style** – openness for **spontaneity** ↔ Pupil’s contributions → Pupil’s level of **complex thinking**

> Pupil’s **(mis)conceptions** ↔ Teacher’s understanding of (mis)conceptions and enactment upon those (mis)concepts

> Teacher’s focus on **conceptual understanding** (vs. declarative knowledge) ↔ Pupil’s understanding (vs. declarative knowledge)
Questions

How can we measure the emergence of PCK (EPCK) over short-term time scale of teacher-pupil interaction?

- Which variables related to PCK are observable (EPCK) in order to build an instrument for time serial measurements?
- What are the principal factors of EPCK?
- How is EPCK established through real-time interaction considering these principal factors.
Method

> Participants:
  - Experienced educator Mobile Planetarium;
  - 1 class of pupils from grade 3

> Procedure:
  - observations of EPCK educators – highly ranked educator was selected;
  - Instrument: based on observations and literature;
  - Video taped activity, first 700 sec coded;

> Analysis:
  - Factor analysis; Kohonen Clustering
<table>
<thead>
<tr>
<th>EPCK</th>
<th>Teaching style</th>
<th>Adult</th>
<th>Children</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Reaction on (mis)conceptions</td>
<td>Reaction on spontaneity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Appearance</td>
<td>Judgement</td>
</tr>
<tr>
<td>Open</td>
<td>Evoking conceptual understanding</td>
<td>Reaction on non-, mis- or fragmented concepts</td>
<td>Neutral</td>
</tr>
<tr>
<td></td>
<td>Evoking declarative knowledge</td>
<td>No reaction</td>
<td>Negative</td>
</tr>
<tr>
<td>Closed</td>
<td>No reaction</td>
<td>Negative</td>
<td>Explaining</td>
</tr>
</tbody>
</table>

*Note: The table outlines the relationship between EPCK, teaching style, and observable variables ( conclusion: observable variables are influenced by teaching style and reaction on (mis)conceptions and spontaneity.)*
Principal Factors resulting from the coded time series

3 factors explaining 61% of the variance

Rotated Factor 1: 24% variance
Main variables, corr. > .60:
- Conceptual Understanding (P)
- Questions evoking Conceptual Understanding (T)
- Reactions on question teacher (P)
- Reaction on children’s non-spontaneous reaction (T)
- Positive feedback (T)
- Misconceptions (P)
- Information and instruction (T)*
Principal Factors resulting from the coded time series

3 factors explaining 61% of the variance

Rotated Factor 1: 24% variance
Main variables, corr. > .60:

- Conceptual Understanding (P)
- Questions evoking Conceptual Understanding
- Reaction on question teacher (P)
- Reaction on children’s non-spontaneous reaction (T)
- Positive feedback (T)
- Misconceptions (P)
- Information and instruction (T)*
Principal Factors resulting from the coded time series

3 factors explaining 61% of the variance

Rotated Factor 1: 24% variance
Main variables, corr. >.60:
- Conceptual Understanding (P)
- Questions evoking Conceptual Understanding (T)
- Reactions on question teacher (P)
- Reaction on children's non-spontaneous reaction (T)
- Positive feedback (T)
- Misconceptions (P)
- Information and instruction (T)*

Rotated Factor 2: 21% variance
Main variables, corr. >.60:
- Reaction on spontaneity (T)
- Neutral feedback (T)
- Initiation of the teacher (T)*
- Feedback by means of explaining (T)
- Fragmented concepts (P)
Principal Factors resulting from the coded time series
3 factors explaining 61% of the variance

Rotated Factor 1: 24% variance
Main variables, corr. >.60:
- Conceptual Understanding (P)
- Questions evoking Conceptual Understanding (T)
- Reactions on question teacher (P)
- Reaction on children's non-spontaneous reaction (T)
- Positive feedback (T)
- Misconceptions (P)
- Information and instruction (T)*

Rotated Factor 2: 21% variance
Main variables, corr. >.60:
- Reaction on spontaneity (T)
- Neutral feedback (T)
- Initiation of the teacher (T)*
- Feedback by means of explaining (T)
- Fragmented concepts (P)

* Teacher guided Pupil centered EPCK
Principal Factors resulting from the coded time series

3 factors explaining 61% of the variance

Rotated Factor 1: 24% variance
Main variables, corr. >.60:
- Conceptual Understanding (P)
- Questions evoking Conceptual Understanding (T)
- Reactions on question teacher (P)
- Reaction on children's non-spontaneous reaction (T)
- Positive feedback (T)
- Misconceptions (P)
- Information and instruction (T)*

Rotated Factor 2: 21% variance
Main variables, corr. >.60:
- Reaction on spontaneity (T)
- Neutral feedback (T)
- Initiation of the teacher (T)*
- Feedback by means of explaining (T)
- Fragmented concepts (P)

Rotated Factor 3: 18% variance
Main variables, corr. >.60:
- Declarative knowledge (P)
- Correct concepts (P)
- Spontaneous reaction (P)
- No follow-up feedback (T)
Principal Factors resulting from the coded time series

3 factors explaining 61% of the variance

Rotated Factor 1: 24% variance
- Conceptual Understanding (P)
- Questions evoking Conceptual Understanding (T)
- Reactions on question teacher (P)
- Reactions on children's non-spontaneous reaction (T)
- Positive feedback (T)
- Misconceptions (P)
- Information and instruction (T)

Rotated Factor 2: 21% variance
- Reaction on spontaneity (T)
- Neutral feedback (T)
- Initiation of the teacher (T)
- Feedback by means of explaining (T)
- Fragmented concepts (P)

Rotated Factor 3: 18% variance
- Declarative knowledge (P)
- Correct concepts (P)
- Spontaneous reaction (P)
- No follow-up feedback (T)
Factors over time

FR1: Teacher guided EPCK
FR2: pupil centered EPCK
FR3: Spontaneous knowledge reproduction
### Clusters of Factors

<table>
<thead>
<tr>
<th>Cluster_1</th>
<th>Test value</th>
<th>Cluster_2</th>
<th>Test value</th>
<th>Cluster_3</th>
<th>Test value</th>
</tr>
</thead>
<tbody>
<tr>
<td>[15,6%]</td>
<td></td>
<td>[56,6%]</td>
<td></td>
<td>[27,9%]</td>
<td></td>
</tr>
<tr>
<td>109 Examples</td>
<td></td>
<td>396 Examples</td>
<td></td>
<td>195 Examples</td>
<td></td>
</tr>
<tr>
<td>FR_1</td>
<td>20,92</td>
<td>FR_3*</td>
<td>-9,01</td>
<td>FR_2</td>
<td>16,76</td>
</tr>
<tr>
<td>FR_2*</td>
<td>-2,47</td>
<td>FR_2*</td>
<td>-13,35</td>
<td>FR_3</td>
<td>14,98</td>
</tr>
<tr>
<td>FR_3*</td>
<td>-6,71</td>
<td>FR_1*</td>
<td>-13,42</td>
<td>FR_1*</td>
<td>-2,08</td>
</tr>
</tbody>
</table>

---

**FR1**: Teacher guided EPCK

**FR2**: Pupil centered EPCK

**FR3**: Spontaneous knowledge reproduction
# Clusters of factors

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Test value</th>
<th>Test value</th>
<th>Test value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CL1: Teacher guided EPCK</td>
<td>FR1</td>
<td>20.92</td>
<td>-2.47</td>
</tr>
<tr>
<td>CL3: Spontaneous knowledge reproduction</td>
<td>FR3*</td>
<td>16.76</td>
<td>14.98</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Examples</th>
<th>Test value</th>
<th>Test value</th>
<th>Test value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CL1: Teacher guided EPCK</td>
<td>109</td>
<td>20.92</td>
<td>-2.47</td>
<td>-6.71</td>
</tr>
<tr>
<td>CL2: Pupil centered EPCK</td>
<td>396</td>
<td>-9.01</td>
<td>-13.35</td>
<td>-13.42</td>
</tr>
<tr>
<td>CL3: Spontaneous knowledge reproduction</td>
<td>195</td>
<td>16.76</td>
<td>14.98</td>
<td>-2.08</td>
</tr>
</tbody>
</table>

FR1: Teacher guided EPCK

FR2: Pupil centered EPCK

FR3: Spontaneous knowledge reproduction

CL1: Teacher guided EPCK

CL3: Pupil Centered approach
Cluster 2: 56.6 % 396 Examples

Initiative (T)
Information and instruction (T)

No follow-up feedback (T)*
Neutral feedback (T)*
Spontaneous reaction (P)*
Reactions on question teacher (P)*
Feedback by means of questioning (T)*
Feedback by means of explaining (T)*
Positive Feedback (T)*
Conceptual understanding (P)*
Questions evoking conceptual understanding (T)*
Reactions on spontaneity (T)*
Cluster 2: 56,6 % 396 Examples

Initiative (T)

Information and instruction (T)

No follow-up feedback (T)*
Neutral feedback (T)*
Spontaneous reaction (T)*
Reactions on spontaneity (T)*
Feedback by means of questioning (T)*
Feedback by means of explaining (T)*
Positive Feedback (T)*
Conceptual understanding(P)*
Questions evoking conceptual understanding(T)*
Reactions on spontaneity (T)*
Clusters and factors over time

CL1: FR 1- Teacher guided EPCK

CL2: Teacher’s Closed Initiation

CL3: FR 2 and FR 3 - Pupil Centered approach
P: The Moon is also moving
T: The Moon also, you see it over there. And, in a while when we wait we see the Sun set. Do you know what happens then?
P: Then the Moon will come
T: Well no, the Moon is already here you see. So the Moon can also be in the sky at daytime
P: Then it is night
T: Indeed then it will become night, it becomes dark
P: The Moon is also moving.
T: The Moon is also moving there. And, in a while when we see the Sun we see what happens.
P: Then the Moon will come.
T: Well no, the moon is already there. So the sky at daytime you see. So then it becomes dark.
P: Then it is night.
T: Indeed then it will become the night, it becomes dark.

T: Do you know a constellation?
P: Bear, Orion, Big Bear
T: The Big bear indeed, that is the one I want to talk about
P: Orion, Virgo, Cancer
T: Very good
P: Taurus, and what about Aries?
T: Actually I want to show you some
P: Leo
T: The Big bear indeed, that is the one I want to talk about
P: Orion, Virgo, Cancer
T: Very good
P: Leo
T: The Big bear indeed, that is the one I want to talk about
P: Orion, Virgo, Cancer
T: Very good
P: Leo

FR1: Teacher guided EPCK
FR2: Pupil centered EPCK
FR3: Spontaneous knowledge reproduction
P: The Moon is also moving
T: The Moon also, you see it over there. And, in a while when we wait we see the Sun set. Do you know what happens then?

P: Then the Moon will come
T: Well no, the moon is already here you see. So the sky at daytime becomes dark.

P: Can you show us constellation Virgo?
T: That one I will show you in a moment….
Discussion

› We are able to find clusters that behave like attractor states

› In this time-series the dominant state is ‘Teacher Closed Initiative’, but the pattern is variable

› EPCK: combination of Teacher Guided and Pupil Centered EPCK

› Relevance: study provides a concrete method for measuring EPCK over time as well as an illustration of such a process
Discussion

- We are able to find clusters that behave like attractor states.
- In this time-series the dominant state is ‘Teacher Closed Initiative’, but the pattern is variable.
- EPCK: combination of Teacher Guided and Pupil Centered EPCK
- Relevance: study provides a concrete method for measuring EPCK over time as well as an illustration of such a process.

It is important to observe EPCK over time.
Questions?

Carla Geveke

c.h.geveke@rug.nl

c.h.geveke@pl.hanze.nl