

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

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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



Instrument: observable variables

		Adult					Children					
EPCK	Teaching style		Reaction on (mis)conceptions			Reaction on spontaneity	Thinking		Conceptions		Spontaneity	
value	Openness	Type of evoking	Appearance	Judgement	Type of feedback	Type of spontaneity	Complexity	Scientific reasoning	Appearance	Correctness	Appearance	
↑	Open	Evoking conceptual understanding	Reaction on non-, mis- or fragmented conceptions	Neutral	follow-up question	React on spontaneous contributions	Complex	Conceptual understanding	Conceptions	In-correct	Correct	Spontaneous reactions
		Evoking declarative knowledge		Positive		React on contribution (non-spontaneous)		Declarative knowledge		React on question adult		
	Closed		No reaction	Negative	Explaining	initiates	Non-complex		Non-concept		No reaction	
					No feedback	No reaction						



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)***



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- **Questions expected Conceptual Understanding (P)**
- **Reaction question teacher (P)**
- **Reaction children's non-spontaneous reaction (T)**
- **Positive feedback (T)**
- **Misconceptions (P)**
- **Information and instruction (T)***

Teacher guided EPCK



Principal Factors resulting from the coded time series

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Rotated Factor 1: 24% variance

Main variables,

- **Conceptual**

- **Questions ex**

Underst

- **R**

- **R**

spontaneous

- **Positive feed**

- **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 guide



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Teacher guided

Pupil centered EPCK



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Main varia

- **Reaction**

- **Ne**

- **F**

- **explai**

- **Fragn**

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- **Fragn**

Rotated Factor 3: 18%
 variance

Main variables, corr. >.60:

- **Declarative knowledge (P)**

- **Correct concepts (P)**

- **Spontaneous reaction (P)**

- **No follow-up feedback (T)**

Teacher guide

Pupil c



Principal Factors resulting from the coded time series

3 factors explaining 61% of the variance

Rotated Factor 1: 24% variance

Main variables,

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Main varia

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- **explain**

- **Fragment**

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Rotated Factor 3: 18%
 variance

Main variables

- **Declar**

(P)

- **Corr**

- **Spon**

- **No fo**

**Spontaneous
 knowledge
 reproduction**

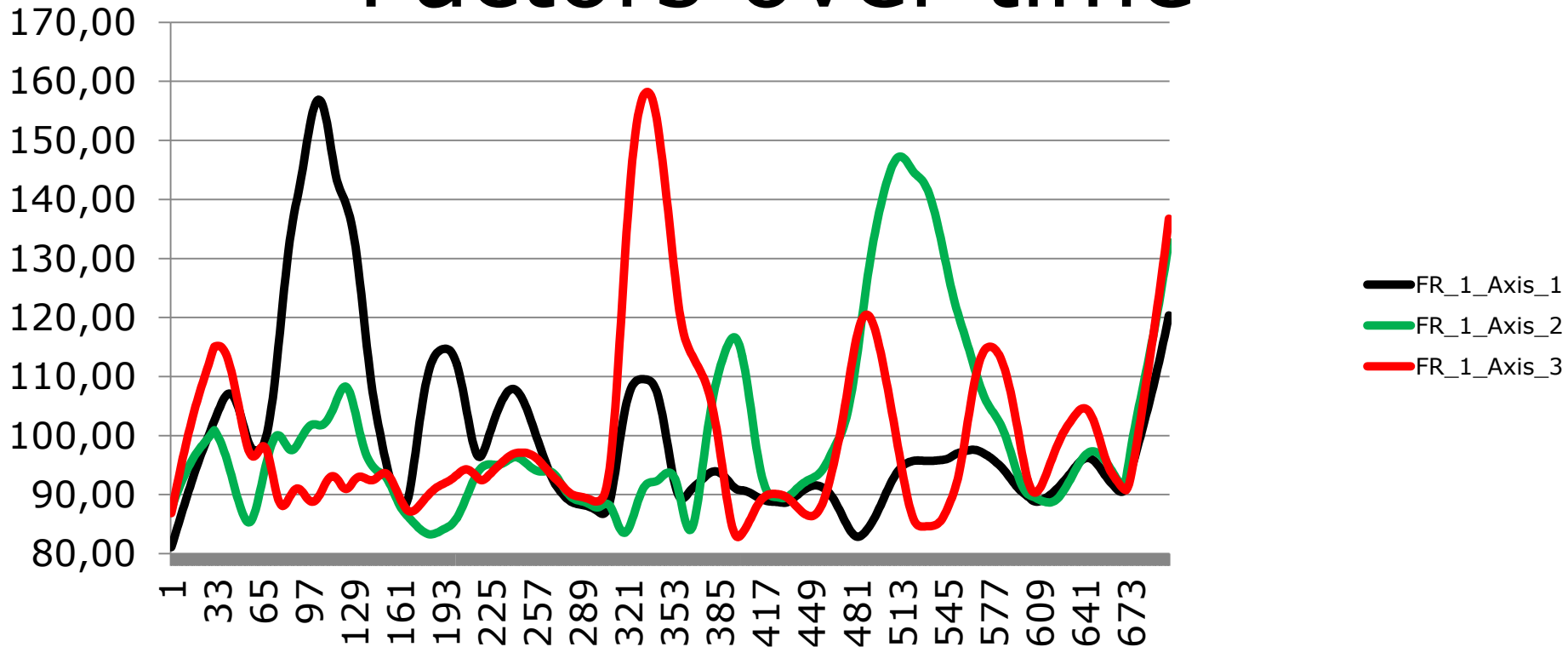
**action (P)
 up feedback (T)**

Teacher guid

Pupil c



Factors over time



**FR1: Teacher guided
 EPCK**

**FR2: pupil centered
 EPCK**

**FR3: Spontaneous
 knowledge reproduction**



Clusters of factors

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

**FR1: Teacher guided
EPCK**

**FR3: Spontaneous
knowledge reproduction**

FR2: Pupil centered EPCK



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**FR1: Teacher guided
EPCK**

**FR3: Spontaneous
knowledge reproduction**

FR2: Pupil centered EPCK

**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 re

Reactions

Feedback on answer (P)*

Feedback on questioning (T)*

Feedback means of explaining (T)*

Positive feedback (T)*

Conceptual understanding(P)*

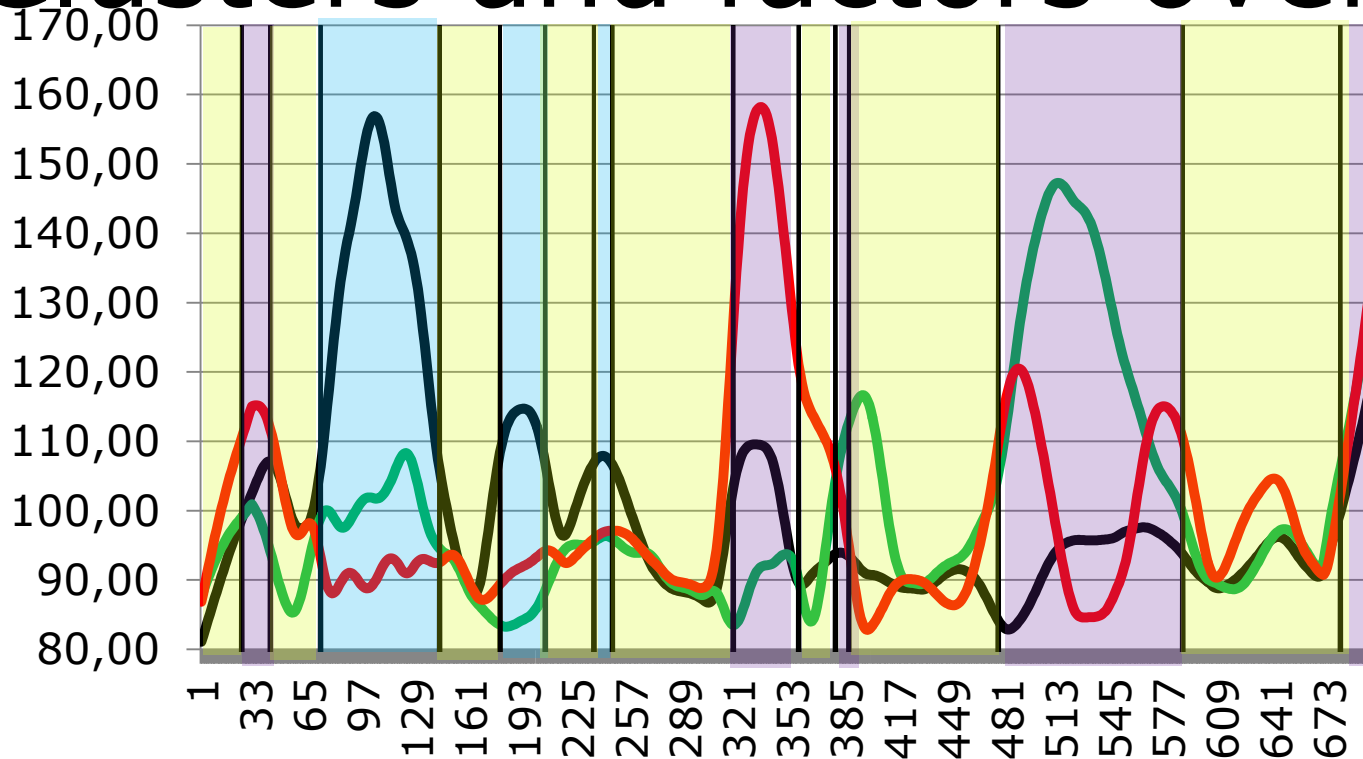
Questions evoking conceptual understanding(T)*

Reactions on spontaneity (T)*

Teacher's Closed Initiation



Clusters and factors over time



FR1: Teacher guided EPCK

FR2: Pupil centered EPCK

FR3: Spontaneous knowledge reproduction

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

Cluster over time



FR1: Teacher guided EPCK

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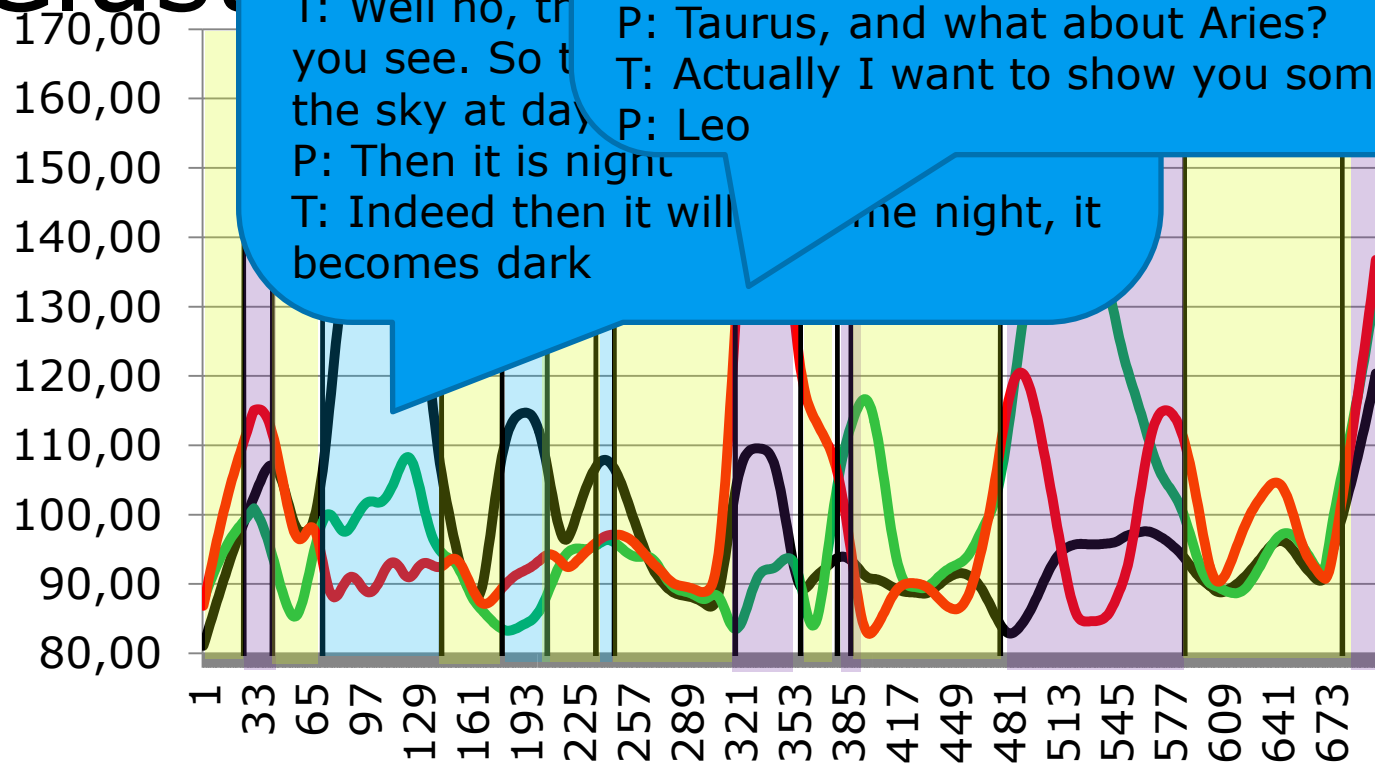


Clust

me

P: The Moon
 T: The Moon there. And, if we see the S what happen
 P: Then the M
 T: Well no, th you see. So t the sky at day
 P: Then it is night
 T: Indeed then it will be 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



FR1: Teacher guided EPCK

FR2: Pupil centered EPCK

FR3: Spontaneous knowledge reproduction

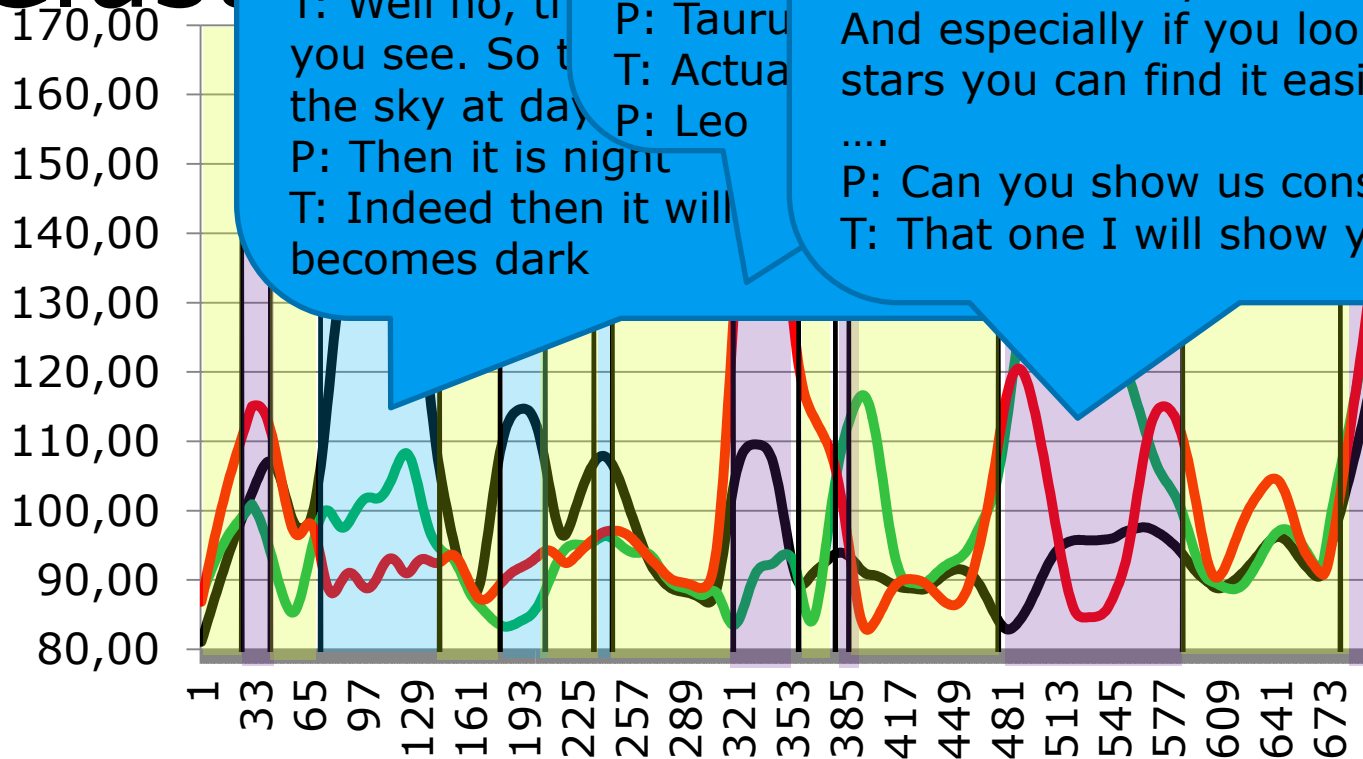
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Clust



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 P: Then it is night
 T: Indeed then it will becomes dark

T: Do yo
 P: Bear,
 T: The B
 I want t
 P: Orion
 T: Very
 P: Tauru
 T: Actua
 P: Leo

P: How do you know that that is the North Star?
 T: Well if you look at the sky it is easy to find the Big Bear, this one. It is recognizable, and than you have to extend this part about five times and then you arrive at the Pole Star. And especially if you look more often to the stars you can find it easily.....

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

FR2: Pupil centered EPCK

FR3: Spontaneous knowledge reproduction

CL1: FR 1- Teacher guided EPCK

CL2: Teacher's Closed Initiation

CL3: FR 2 and FR 3 - Pupil Centered approach



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
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> EPCK:
Cente

and Pupil

**It is important
to observe
EPCK over time**

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



Questions?

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