

# Development of PCK nos in Preservice Teachers

Developed at 2010 EASE Summer School

National Taiwan Normal University

Taipei, Taiwan

July 18~23, 2010

Man-Sam Lo, The University of Hong Kong



# Development of PCKnos

In preservice teachers

---

# Outline

- ◉ What is Nature of Science (NOS)?
- ◉ What is Pedagogical Content Knowledge (PCK)?
- ◉ Why study PCK for teaching nos (PCKnos)?
- ◉ Context of the study
- ◉ Methodology
- ◉ Preliminary findings

# What is NOS?

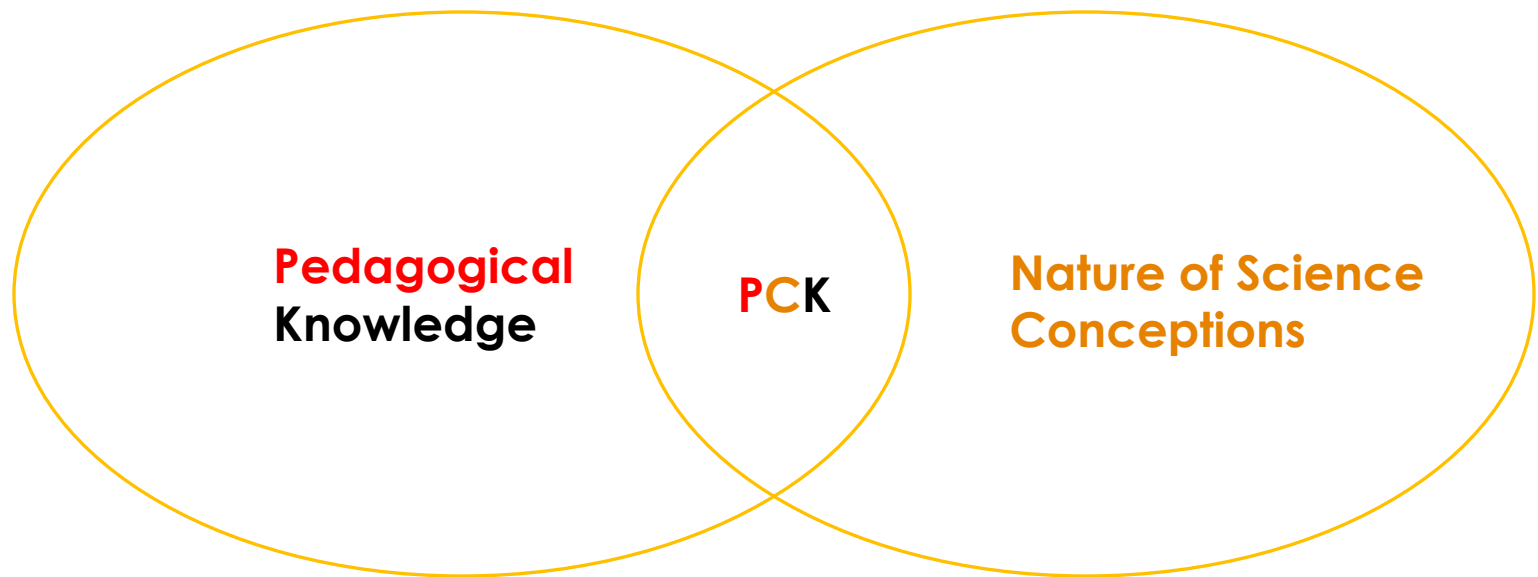
- ◉ Nature of Science
- ◉ Epistemology and Ontology of science
  - ◉ What science is about?
  - ◉ How it works?
  - ◉ How scientific knowledge is generated?
  - ◉ How scientists operate as a social group?
  - ◉ How society and science interact?

# Scientific knowledge is tentative

- ◉ In the past, earth was believed to be centre of the universe
- ◉ Sun was the centre
- ◉ None of them are considered as the centre

# What is PCK?

- ◉ Pedagogical Content Knowledge
- ◉ Shulman (1986, 87)
- ◉ Describing pedagogical knowledge for teaching specific content knowledge (subject matter knowledge)
- ◉ Contentious but useful construct



# Magnusson's framework

- orientation toward science teaching
- knowledge and beliefs about science curriculum
- knowledge and beliefs about students' understanding of specific science topics
- knowledge and beliefs about assessment in science
- knowledge and beliefs about instructional strategies for teaching science



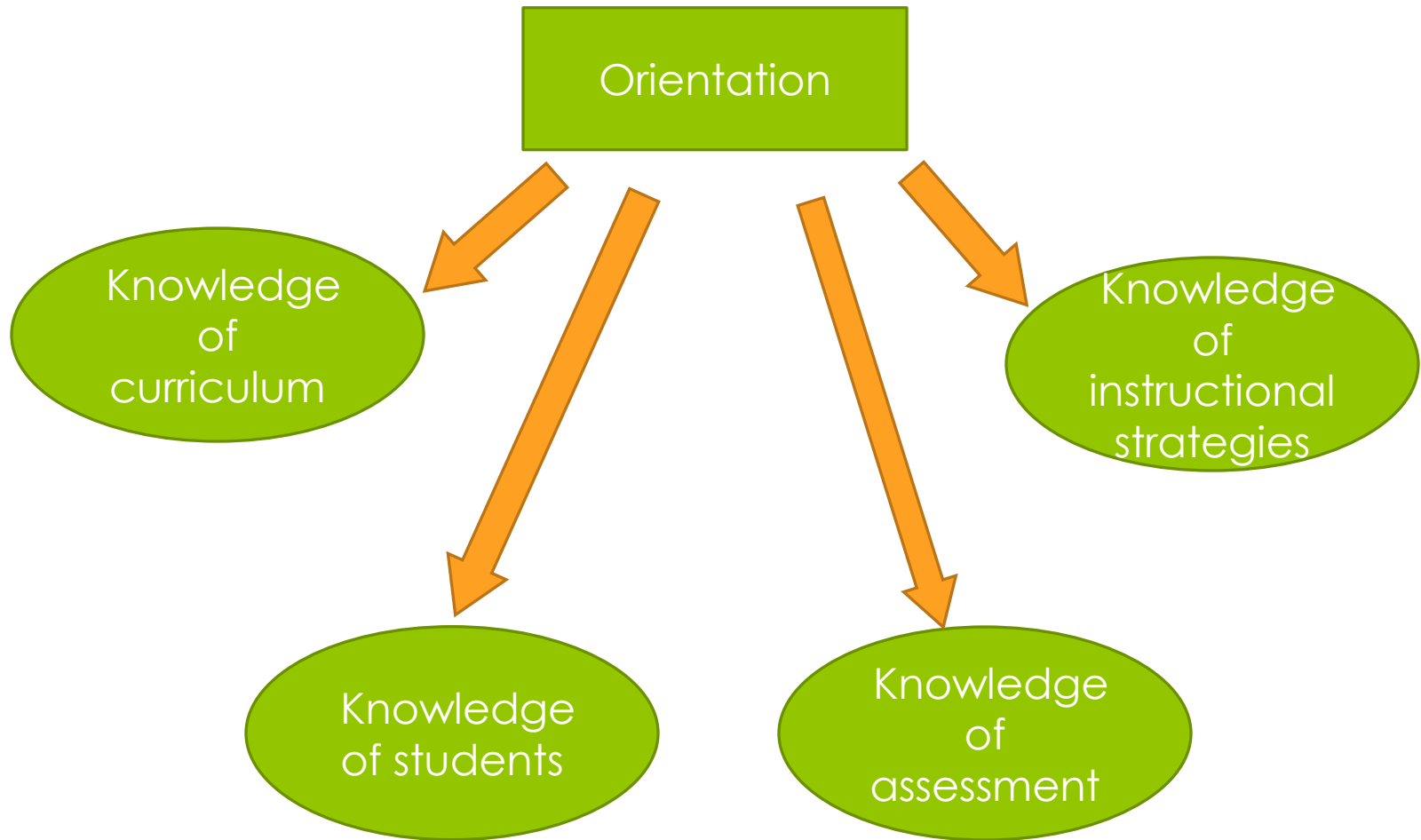
Orientation

Knowledge  
of  
curriculum

Knowledge  
of  
instructional  
strategies

Knowledge  
of  
students

Knowledge  
of  
assessment



# Orientation towards science teaching

- Related to teachers' knowledge and beliefs about the **purposes** and **goals** for teaching science
- *E.g. Didactic*
  - Transmit the facts of science
  - The teacher presents information, generally through lecture or discussion, and questions directed to students are to hold them accountable for knowing the facts produced by science

# Knowledge of Science Curriculum

- Refers to knowledge about **what have to be taught** in a subject discipline
- Knowledge of goals and objectives of the curriculum
  - to what is mandated in the curriculum for teaching a particular topic in a particular grade
  - Knowledge about specific curricular program

# Knowledge of Students' Understanding of Science

- Knowledge of **requirements** of learning
  - Knowing the meaning chemical reaction is required **for** understanding chemical equilibrium
- Knowledge of areas of student **difficulties**
  - Equilibrium concept is difficult for form 4 students **and their common misconceptions**

# Knowledge of Assessment in Science

- ◉ knowledge of **dimensions** for assessing science
  - ◉ What to be assessed
    - ◉ Skill
    - ◉ Knowledge
- ◉ Knowledge of **methods** of assessment
  - ◉ MCQs
  - ◉ Structured questions

# Knowledge of Instructional Strategies

- For the **subject**
  - Field trip
  - Experiments management
- For the **specific topics**
  - Use of physical models for teaching atoms

# Why study PCK for teaching NOS?

- Teaching NOS to students
  - Assuming a prominent status in school science curricula around the world
- Studies on preparing teachers for teaching of NOS is on the rise
- Yet, studies with a focus on PCKnos is particularly rare
  - Virtually no research has used the PCK perspective... as a lens for research on the teaching of NOS. (Lederman, 2007)

# Context of Study

- Teacher preparation program in HK
- Biology Major Methods Course
  - Use of **videos** in teacher education (Sherin, 2004)
  - **Reflective** elements (**Schon**, 1983)
    - **Experience** and **reflection** are foundations for development of PCK (van Driel, 2002)
  - All ten students in the course agreed to participate



# Assignments

- Assignment 1 (Video commenting task)
- Assignment 2 (Video-based lesson study)
- Assignment 3 (Curriculum pack)
- All assignments include a reflection task on what is learnt in completing the assignment

# Assignment 1

- Progressive video viewing task
  - Two authentic classroom videos are provided
  - Transcripts are provided
  - View the videos at 3 different times during the course
    - on entry,
    - before MTP
    - upon exit from the course
  - Find out good and bad features
  - Provide explanations to justify choices

# The two videos

- ◉ Demonstrate
  - ◉ Science content teaching
  - ◉ NOS teaching
- ◉ Argument
  - ◉ If you can notice something worth discussion, at least you have some knowledge about it.
- ◉ Assumed knowledge and noticing goes hand in hand.

# Development of Knowledge Bases as inferred from:

- Assignments submitted at different stages
  - On entry
    - Assignment 1 Video commenting Task 1
  - Before Main Teaching Practicum (MTP)
    - Assignment 1 Video commenting Task 2
  - On exit (after MTP)
    - Assignment 1 Video commenting Task 3
    - Assignment 1 Reflection summary
    - Assignment 2 Video-based lesson study
    - Assignment 3 Curriculum pack
- Validated and supplemented by follow-up interviews

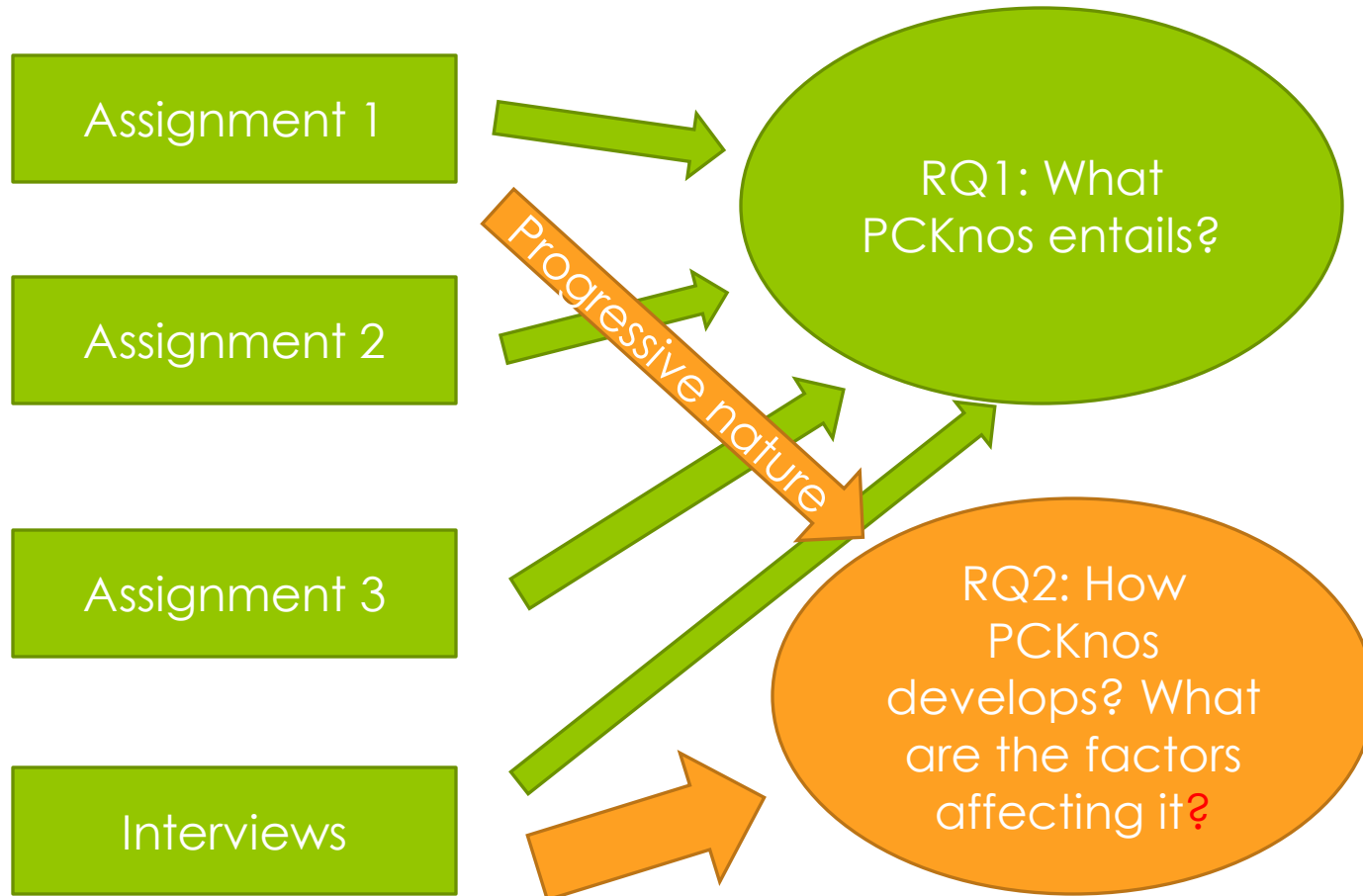
# Research Questions

- What pedagogical content knowledge for teaching nature of science (PCKnos) do the prospective biology teachers possess at different stages of their teacher education course?
- What are the factors that affect the development of the prospective teachers' PCKnos?
  - How do they interact to exert their effect?
  - In particular, what role does the use of video play a part, if any?

# Methodology

- A case study approach
  - Assignments
  - Participant observations in relevant sessions
  - Follow-up interviews

# Data collection







RQ1: What  
PCKnos entails?



A diagram illustrating the components of Teacher Orientation. A large, light green circle is centered on the page. Inside this circle, the word "Orientation" is written in a light green, sans-serif font. Surrounding the central circle are four white ovals, each with a black border. These ovals are positioned at the top-left, top-right, bottom-left, and bottom-right of the central circle. Each oval contains text in a black, sans-serif font. The top-left oval contains "Knowledge of curriculum", the top-right oval contains "Knowledge of instructional strategies", the bottom-left oval contains "Knowledge of assessment", and the bottom-right oval contains "Knowledge of students".

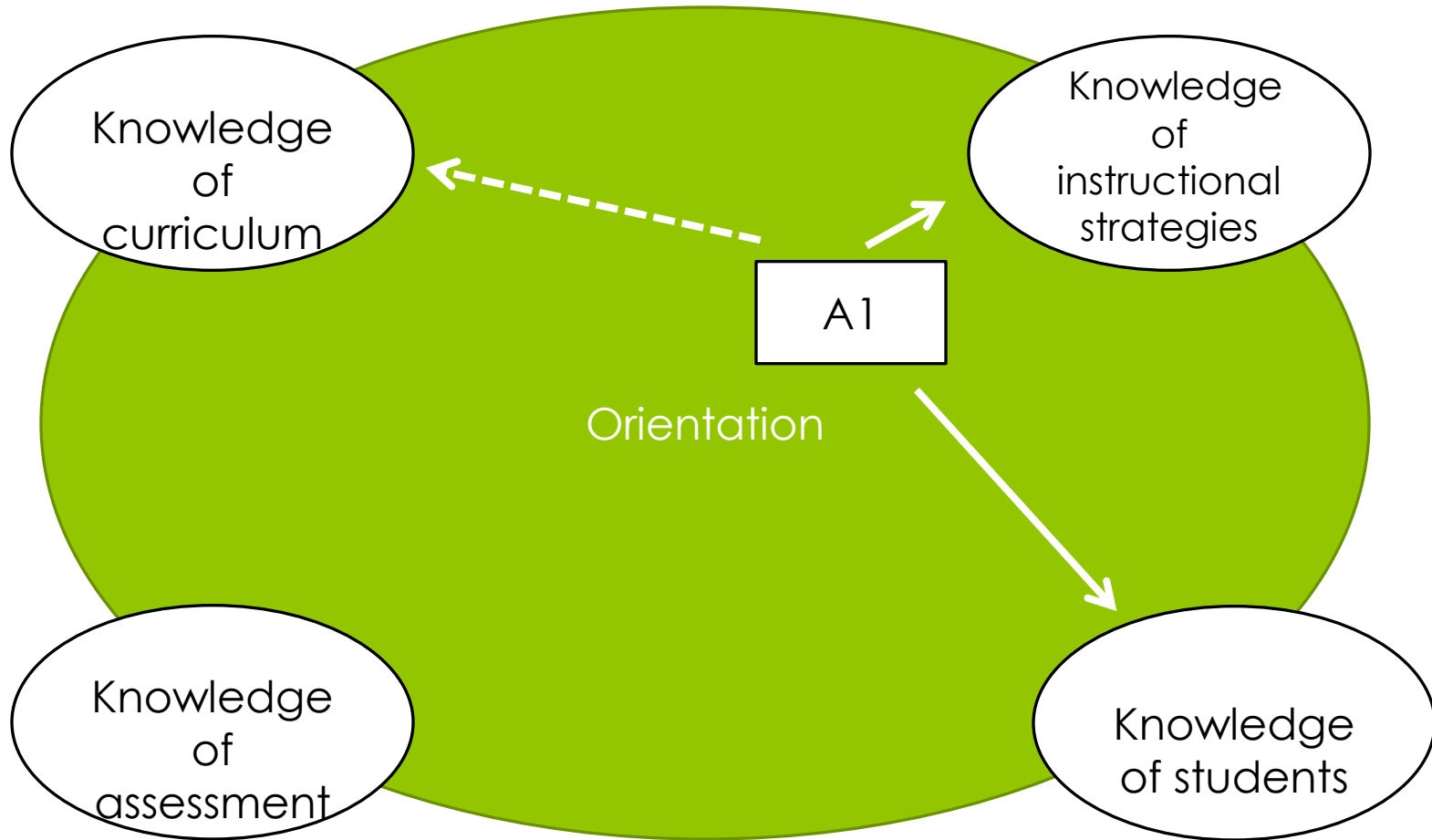
Orientation

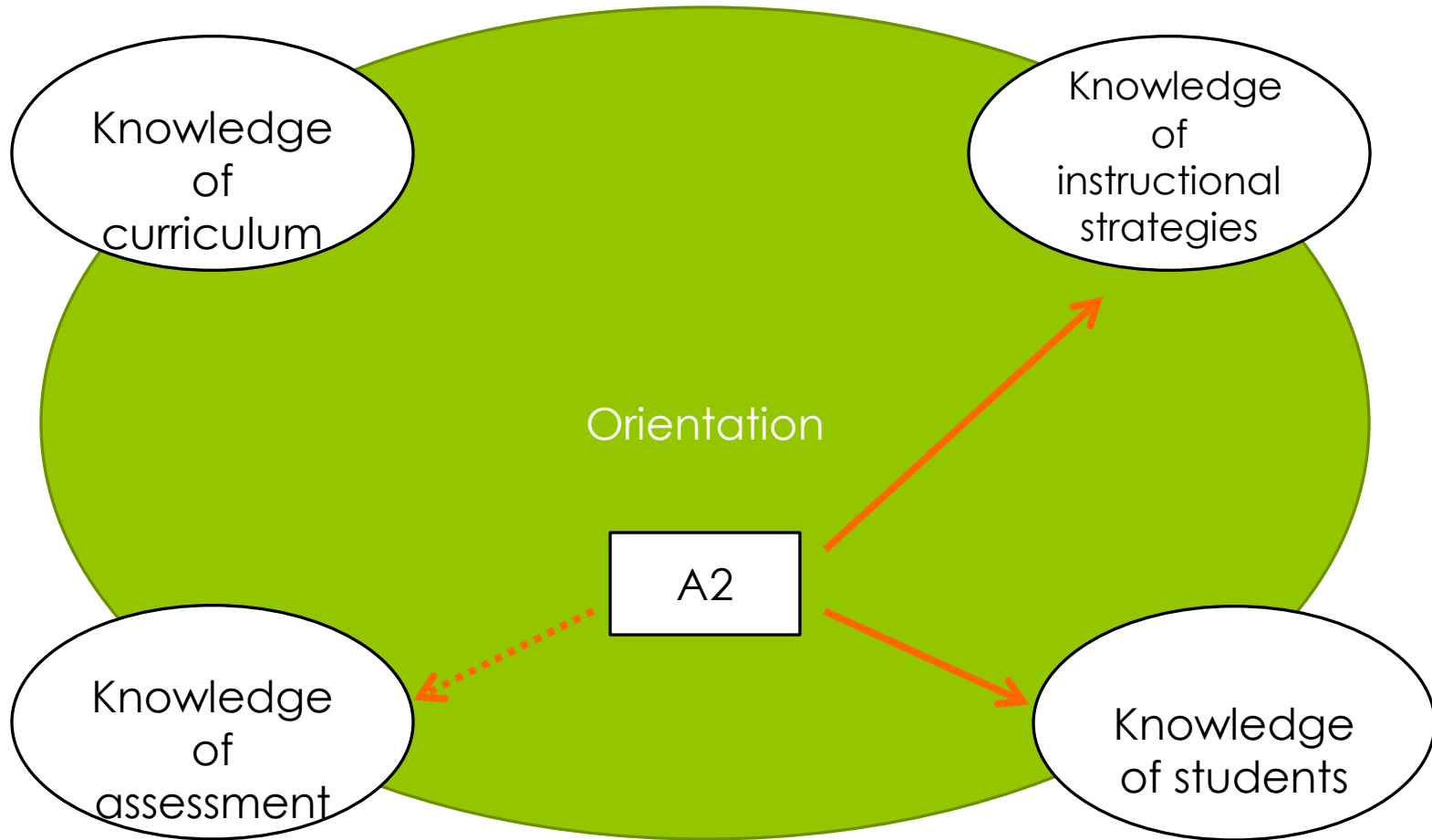
Knowledge  
of  
curriculum

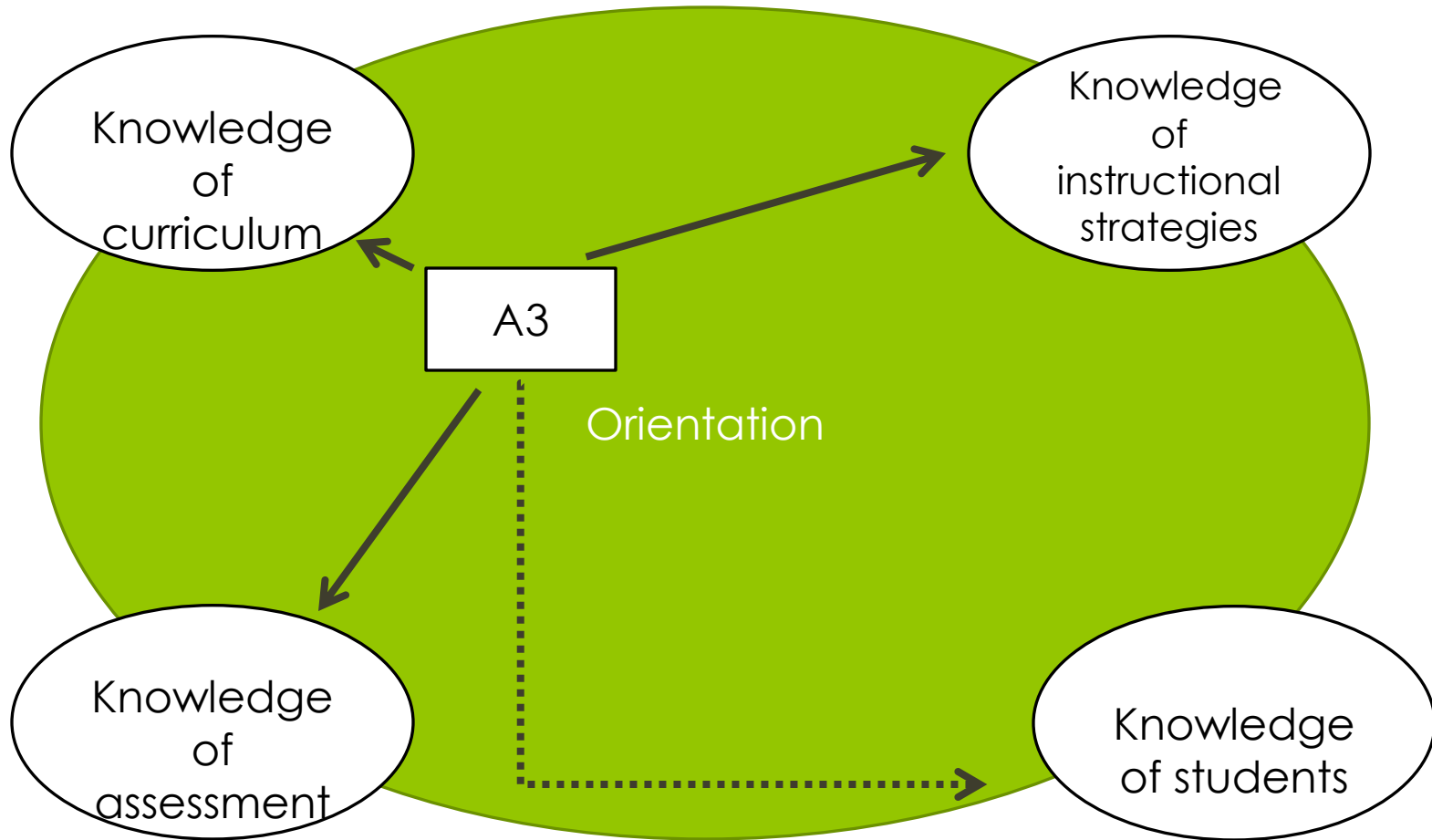
Knowledge  
of  
instructional  
strategies

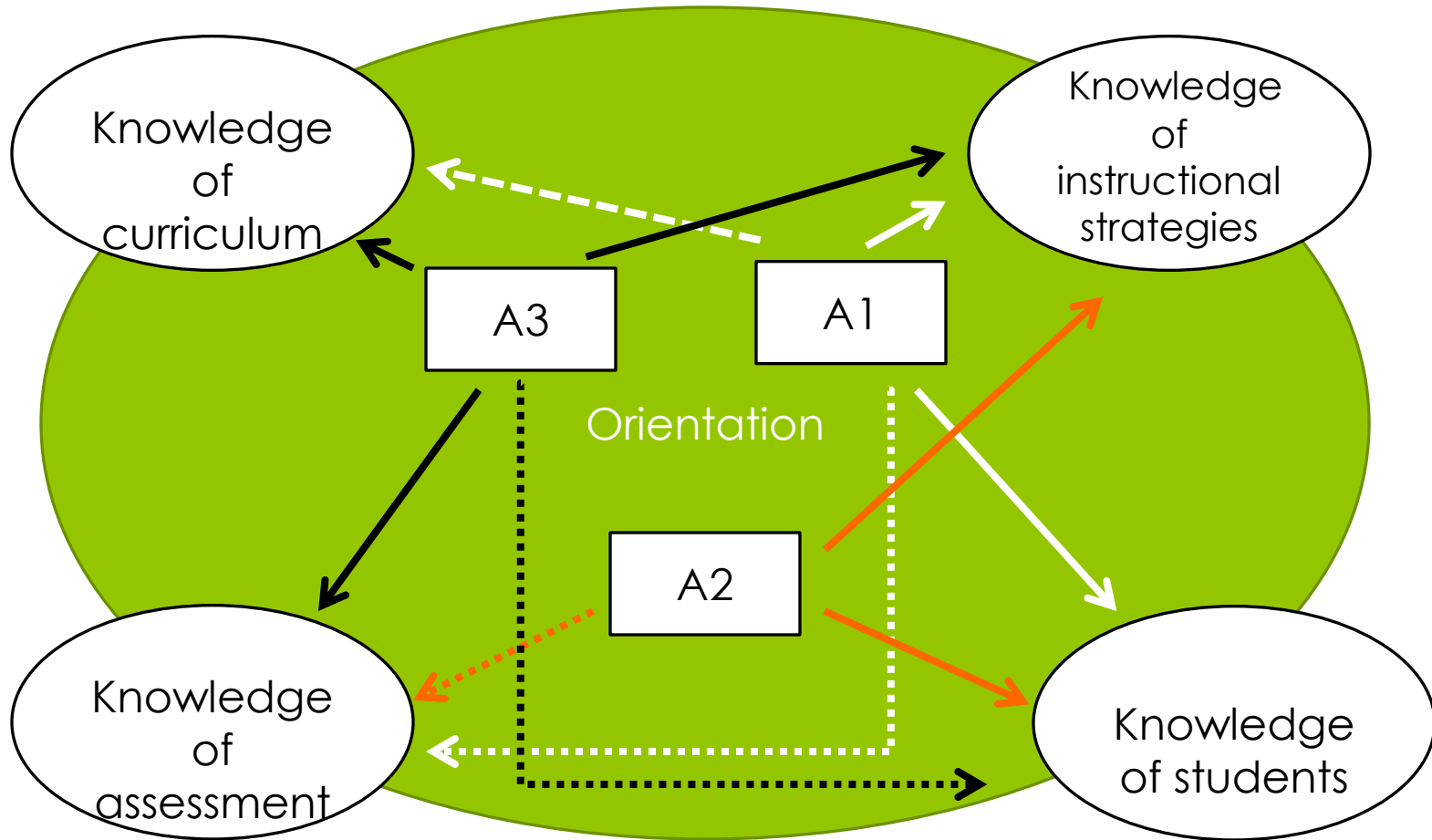
Knowledge  
of  
assessment

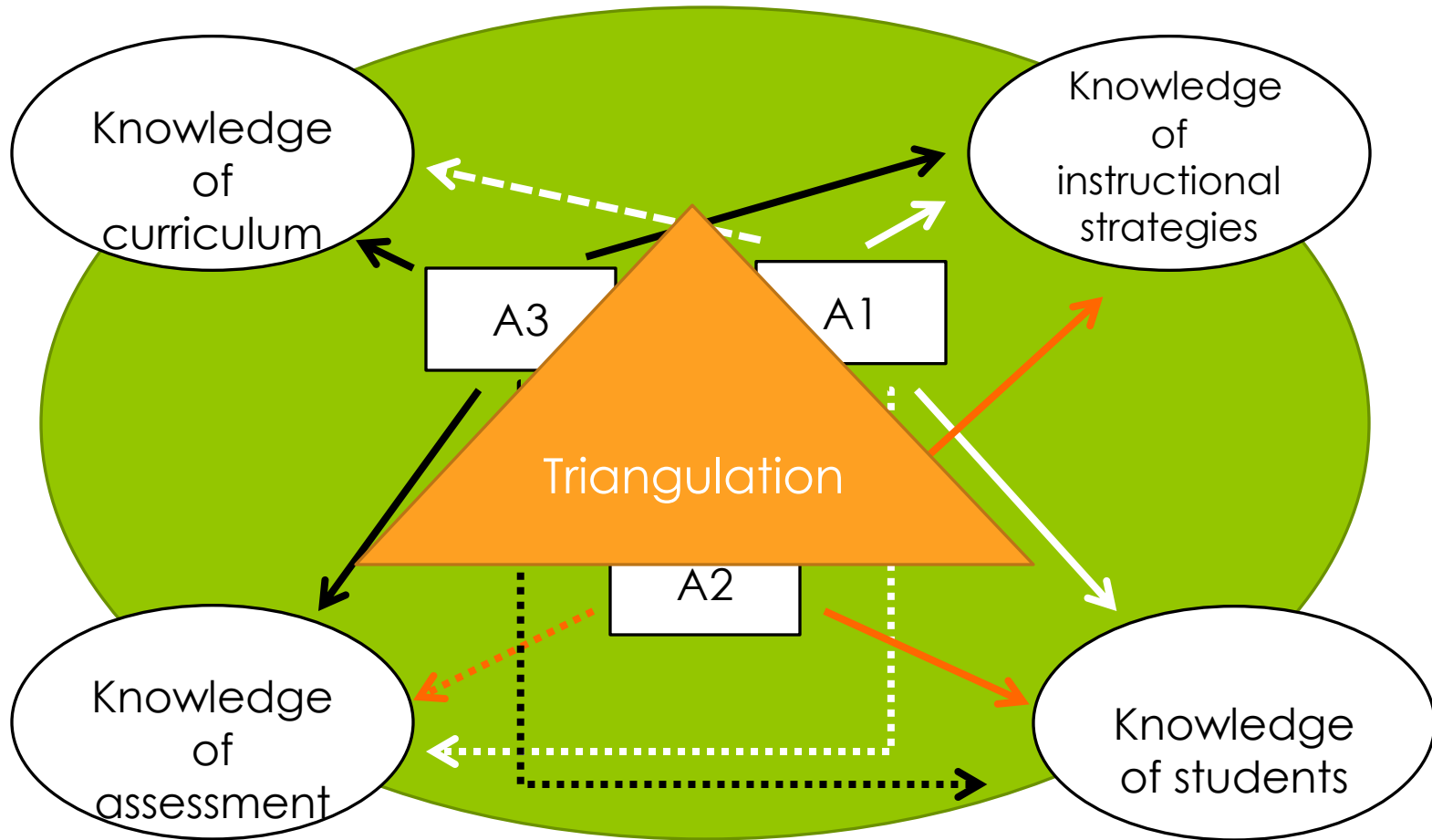
Knowledge  
of students

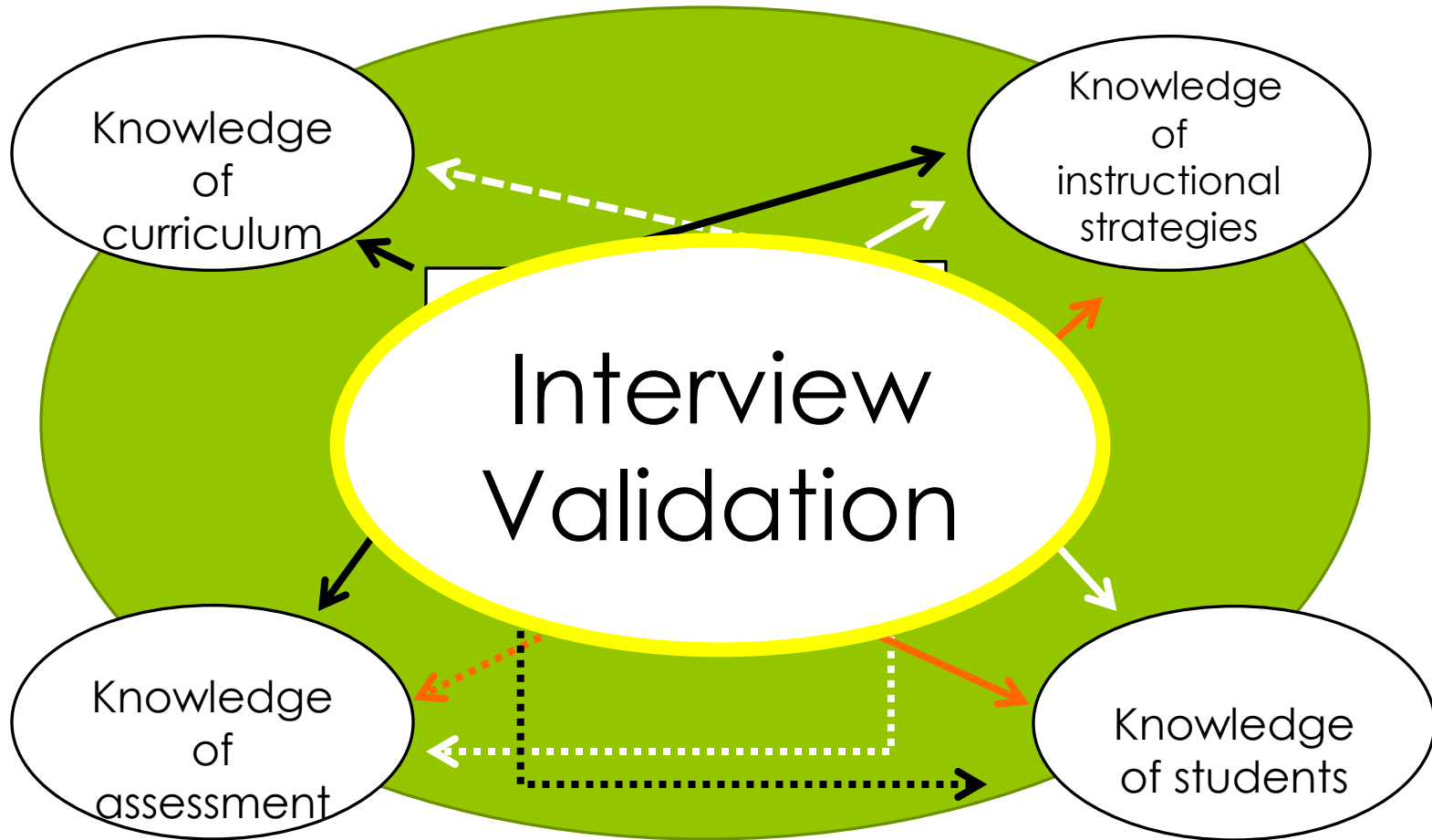




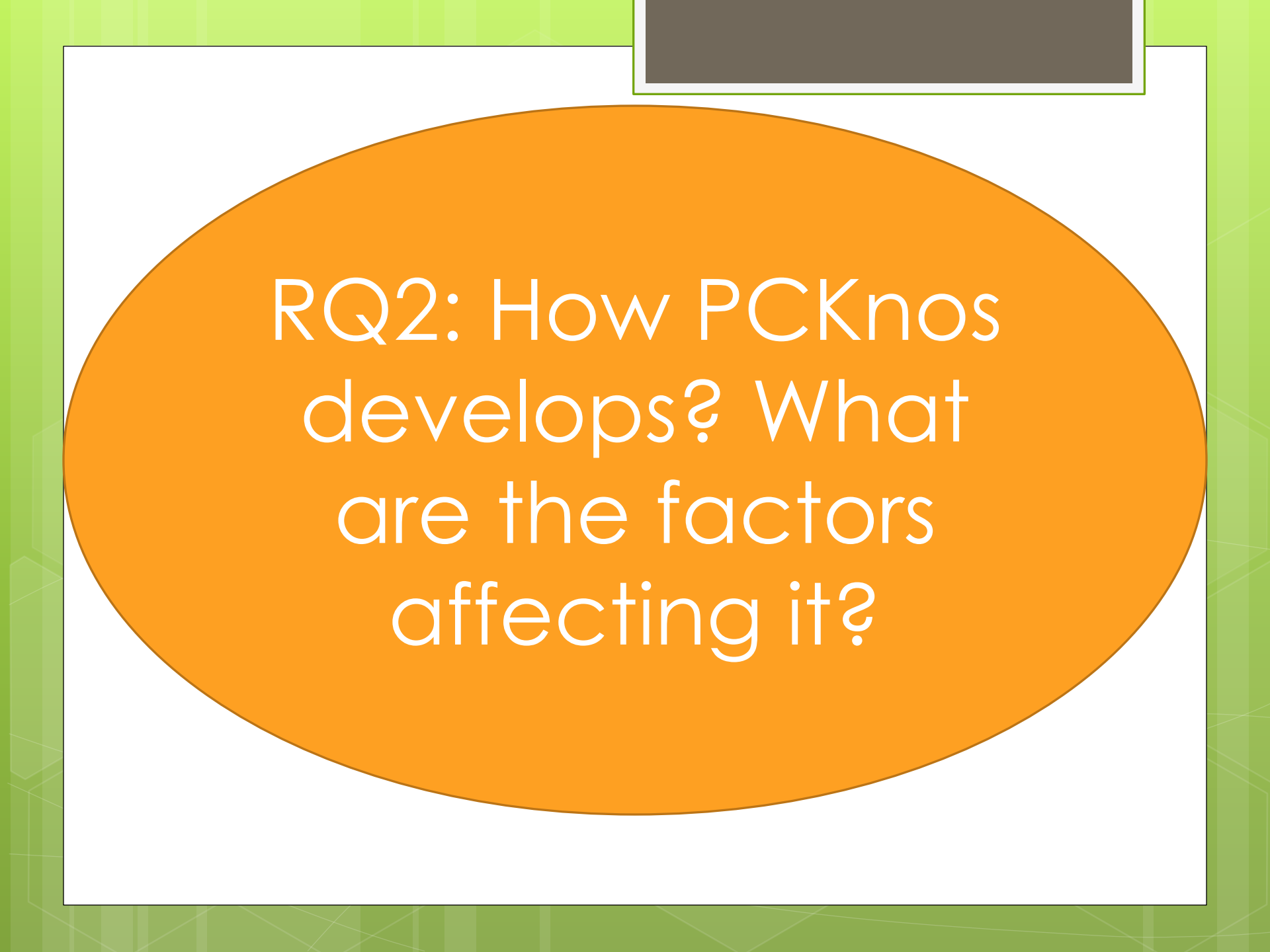




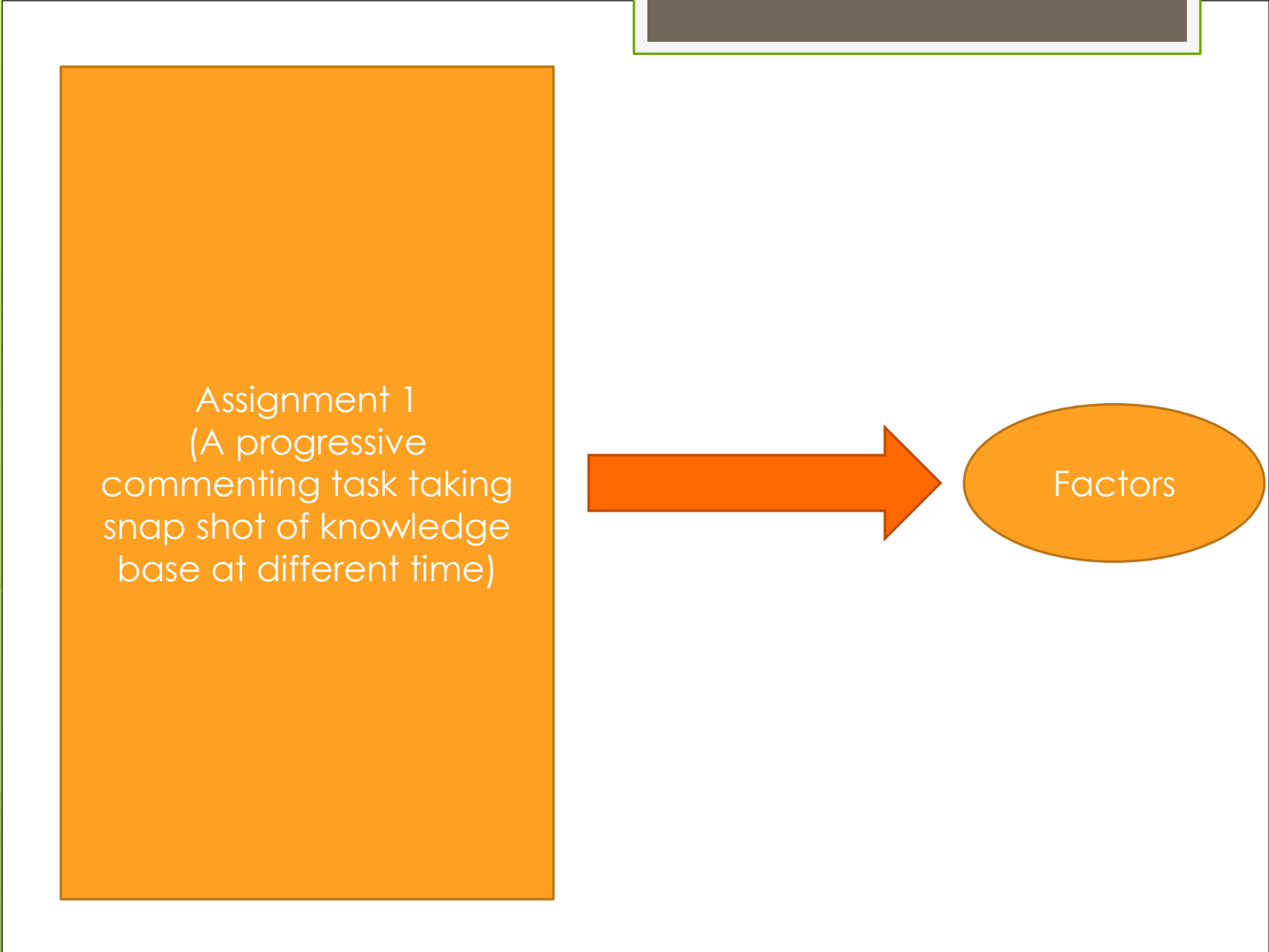






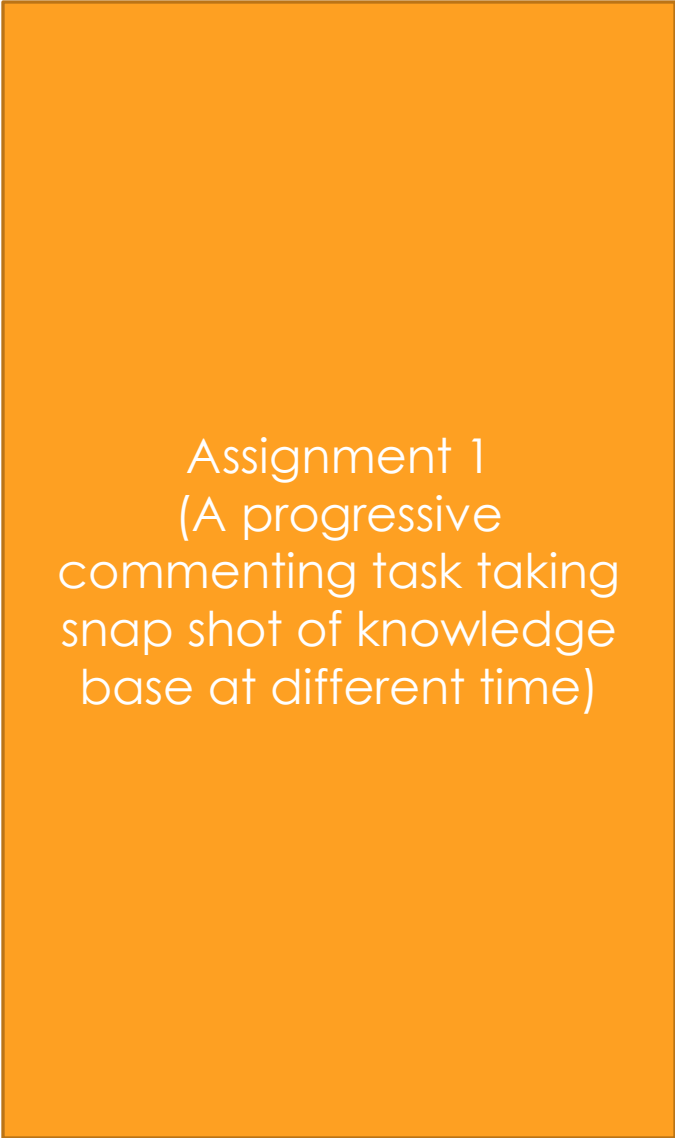




RQ2: How PCKnos  
develops? What  
are the factors  
affecting it?



Assignment 1  
(A progressive  
commenting task taking  
snap shot of knowledge  
base at different time)



```
graph LR; A["Assignment 1  
(A progressive  
commenting task taking  
snap shot of knowledge  
base at different time)"] --> B([Factors]);
```

Factors



Task 1

Assignment 1

Entry  
conceptions

Factors

Task 1



Task 2

Assignment 1

After most  
PGDE  
lectures

Factors

Task 1



Task 2

Assignment 1

Interview  
1

Factors

Task 1



Task 2



Task 3

After MTP

Factors

Task 1



Task 2



Task 3

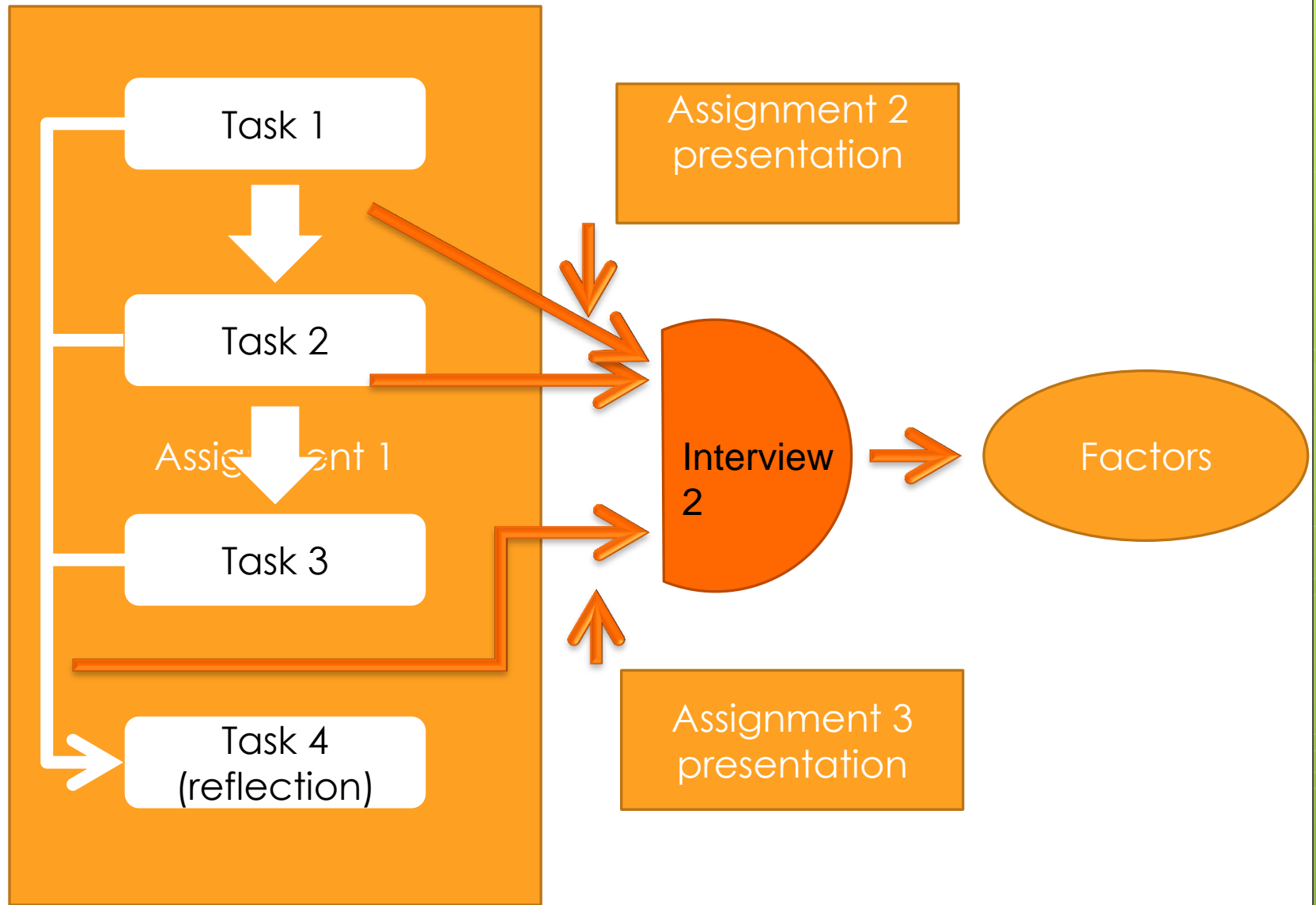
Task 4  
(reflection)

Assignment 2  
presentation

# Exit conception

Factors

Assignment 3  
presentation





# Coding: PCKnos or not?

- In content analysis
  - PCKnos

# Not PCKnos

<i>Asking for self-reflection</i>	<i>50:36-51:10</i>	<i>Helps students to reinforce what have been learnt.</i>
-----------------------------------	--------------------	---

# PCKnos

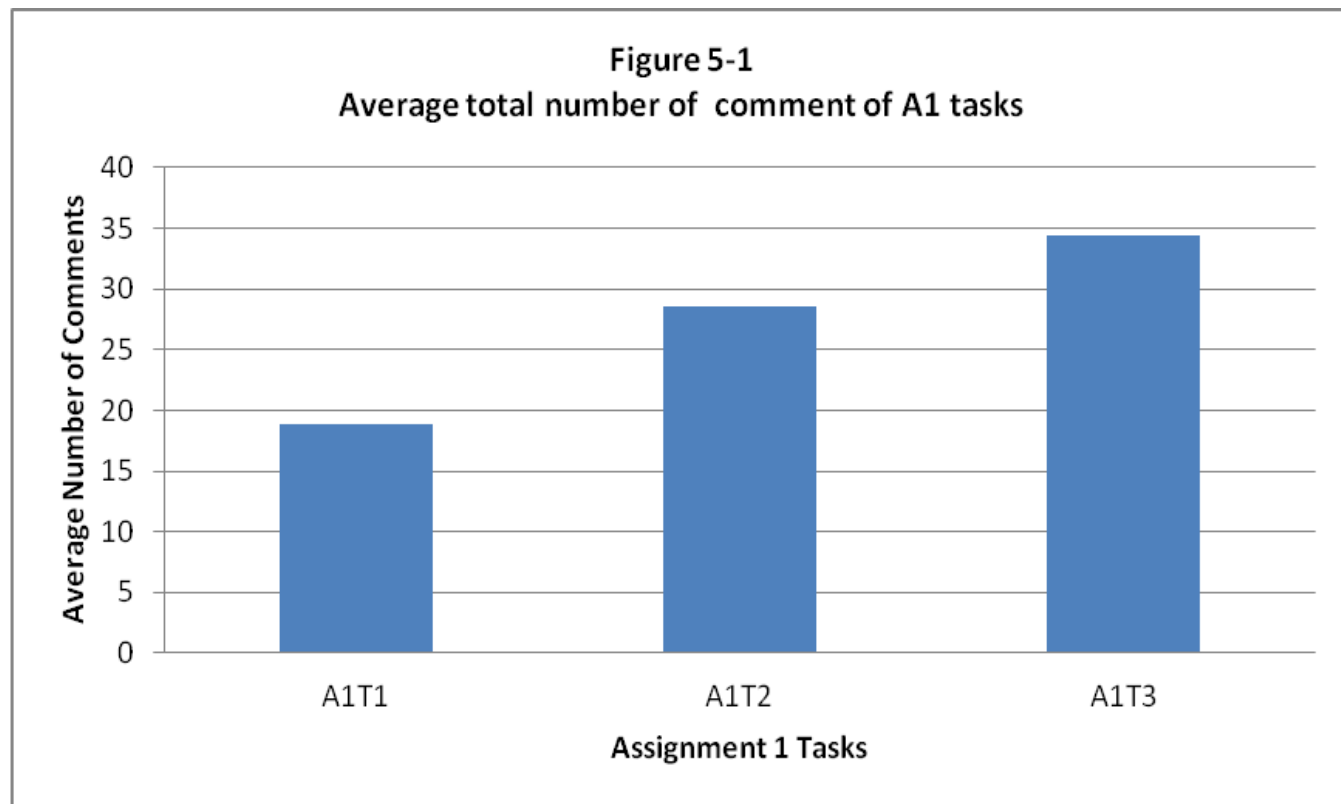
4. Explicit illustration and explanation of NOS idea	10:30-13:15	To introduce the NOS idea of 'observation is affected by background knowledge', the teacher tried to guide student's thinking step by step. She listed out the discoveries of bacteria and explained what was meant by background knowledge using clear examples.
--	-------------	---

# Preliminary Findings

# Growth in PCKnos

- Preliminary coding reveals a considerable high percentage of comments that are related to PCKnos

# Quantitative



# Qualitative (development of PCKnos)

- The teacher started the lesson by stating what the students had learnt in the previous lessons. This helps the students to refresh their memory. He also explained the aim of his lesson and reviewed the steps of scientific inquiry. **He explained to the students the needs for them to develop skills for scientific inquiry. He also used daily life analogy to arouse student's attention.** (Combining A1T123 Case 06)

# Qualitative (factors)

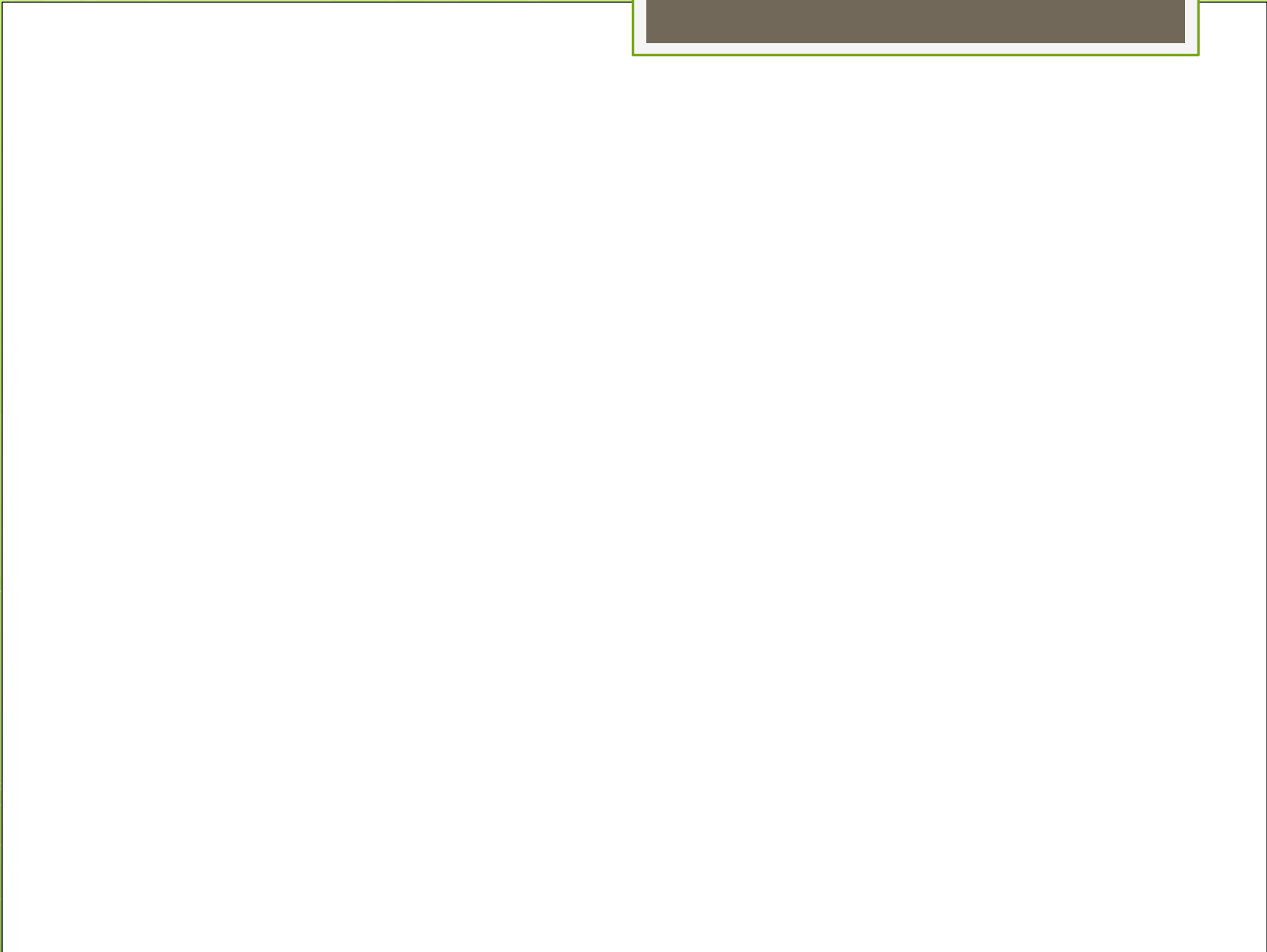
6. Miss Chan asked the class to reflect on what are required when they made hypothesis.	27:07 to 28:18	Miss Chan induced the class to reflect on their own thinking. During reflection, students can realize the elements of making hypothesis by themselves. Again, Miss Chan avoided the use of transmissive teaching.
---	----------------	---

In interview 1: Except very personal factors [that helped me to understand how reflection is required for teaching hypothesis], ES1 and Major Methods lessons talked about student center. I think reflection is a good way for students to construct knowledge.



# Progress of study

- In the middle of second interview



# Value of NOS

- To make sense of the science and manage the technological objects and processes they encounter
- To appreciate science as a major element of contemporary culture
- To develop awareness of the nature of science, and in particular the norms of scientific community, embodying moral commitments which are of general value

# To make sense of socio-scientific issues

- Democratic society
- In making informed decision

# Global warming



## E.g. Interview protocol

- For features that are specifically related to NOS teaching by the participant (Tailored to individuals, not more than four features, select those that changed in three tasks)
  - What were you thinking when you put down this comment? (你寫呢個comment 個時心裏念緊咩?)
  - What helps you realize this? (有咩幫你學到?)
  - (For new comments / suggestions – Your view on this feature has changed. \*What prompt you to make such a change? \*How these things changed your view?)