PONTIFICIA UNIVERSIDAD CATÓLICA DE VALPARAÍSO

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Development of Pedagogical Content Knowledge of Climate Change (PCKcc) in a biology teacher: A longitudinal case study

Catalina Cañete-Llanos & Hernán Cofré

Introduction

On the topic of Climate Change teacher training, research shows that teacher education on the science of CC can improve the learning experience of their students (Bardsley & Bardsley, 2007; Bhattacharya et al., 2021).

However, Pedagogical Content Knowledge of Climate Change (PCK_{CC}) in science teachers is an understudied aspect (Bhattacharya et al., 2021; but see Teed & Franco 2014).

In general, teachers feel very challenged in teaching CC since it involves a political field of action, to which many of them are not accustomed.

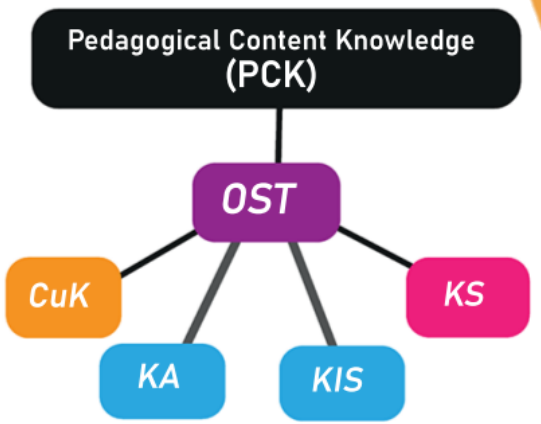
Research questions

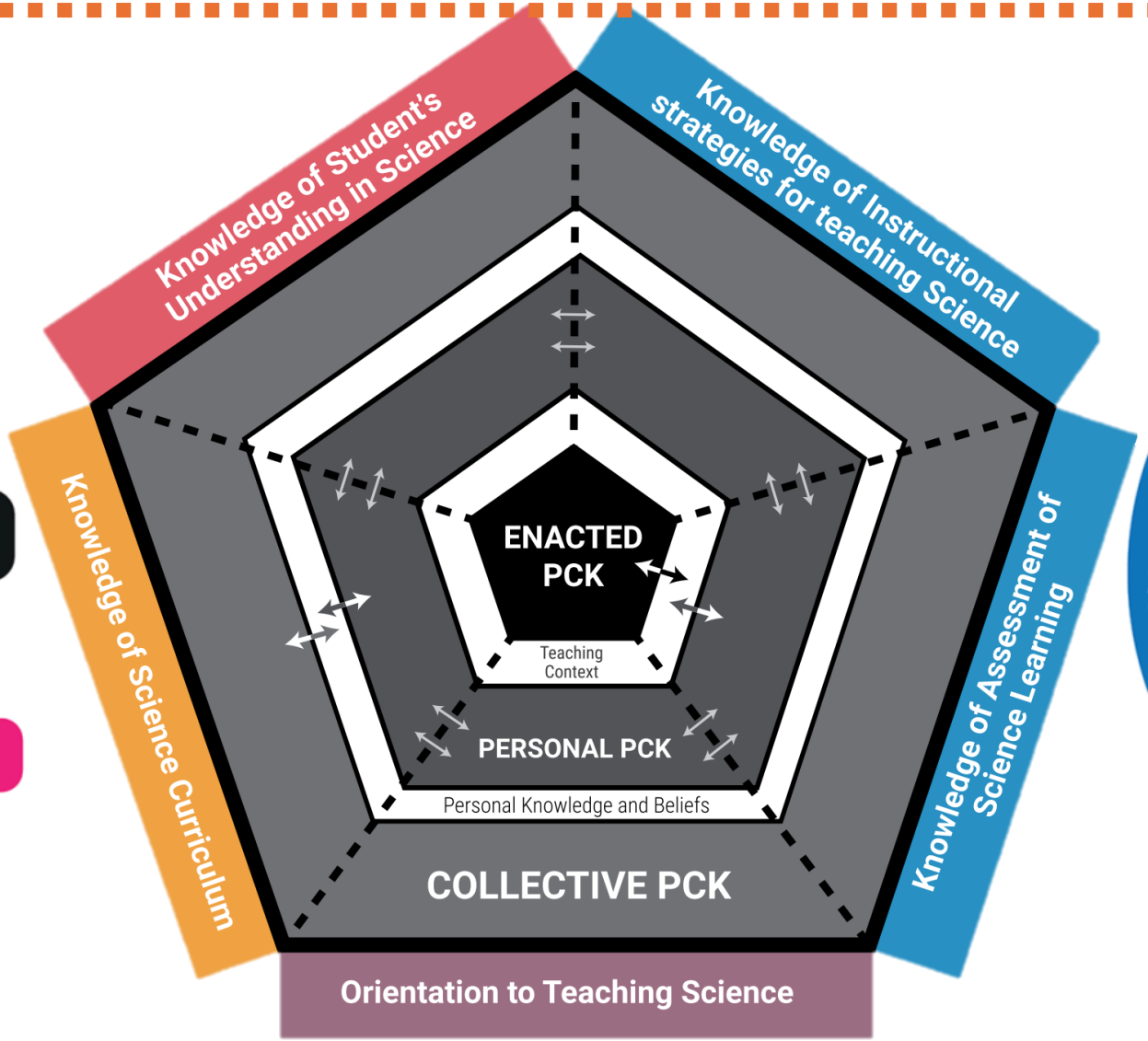
- How develop the five components of the personal PCK of CC ($pPCK_{CC}$) in a biology teacher during teaching 11th grade students in a school in central Chile?

- What factors influence the transition from $pPCK_{CC}$ to enacted PCK of CC ($ePCK_{CC}$)?

Theoretical framework and PCK Models

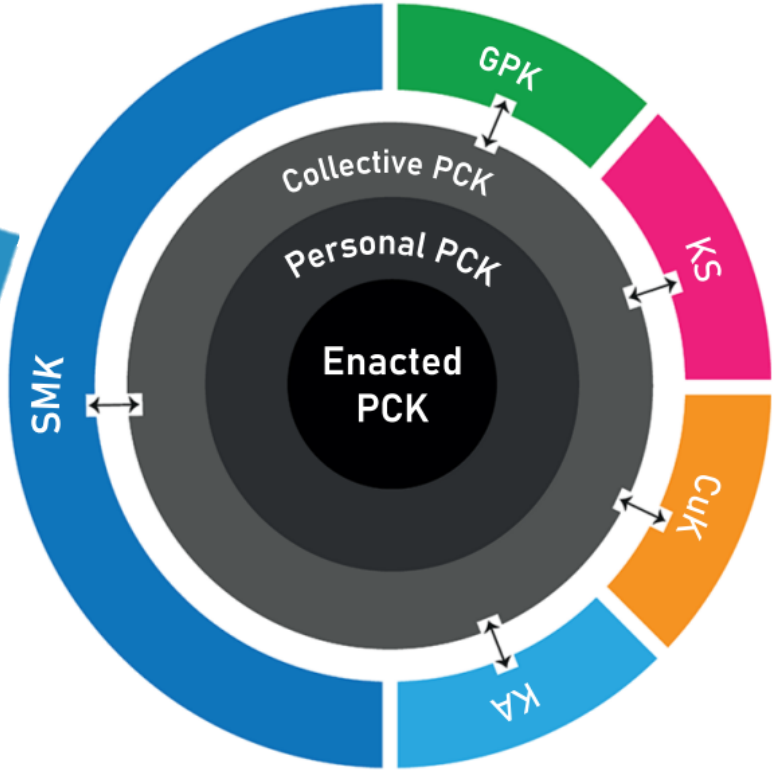
Magnusson, Borko, & Krajcik(1999)





Refined Consensus Model

Carlson & Daehler (2019)



Mixed Model
Vergara, et al. (2024)

Methodology

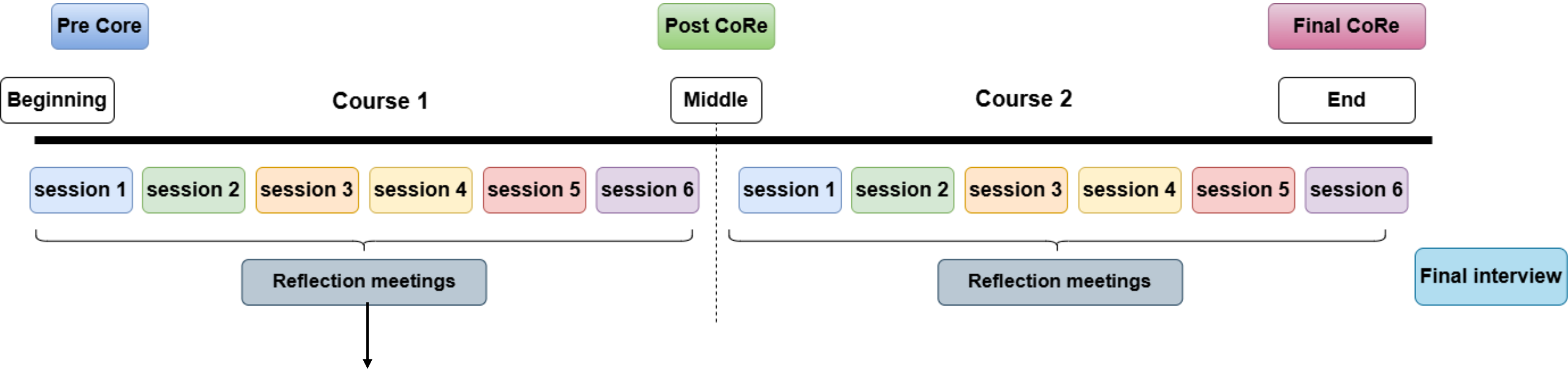
- The study is qualitative in nature, with an interpretive approach and a case study design (Yin, 2018)

Case of study:

- A biology teacher was selected, with more than 20 years of experience: Teacher Adrián (pseudonym)
- Attended a professional development program on teaching climate change through argumentation during the austral summer of 2022
- He taught in a low-income high school, in the subject of Science for Citizenship at grade 11 (15-18 years old students)

Methodology

- Sequency



In each reflection interview the teacher was asked about some critical moment of teaching CC which had been observed by the researcher

Analysis

To describe the teacher's PCK at different times during their lessons, a qualitative data analysis was conducted, in which conceptual coding (Saldaña, 2015; Miles et al., 2019) was guided by theory on PCK.

CoRe

Reflection meetings

Question	Answer	Code	Component
What were or what do you recognize as preconceptions of this topic?	I think that it had a lot of support for a long time. I mean, at least I have been listening to it since the 90's as strong, so they still think that the ozone layer is a very important preconception, they also include ultraviolet radiation and talk about skin cancer.	Importance of the ozone layer Global warming due to ozone layer	Students' knowledge Subcategory: Preconceptions

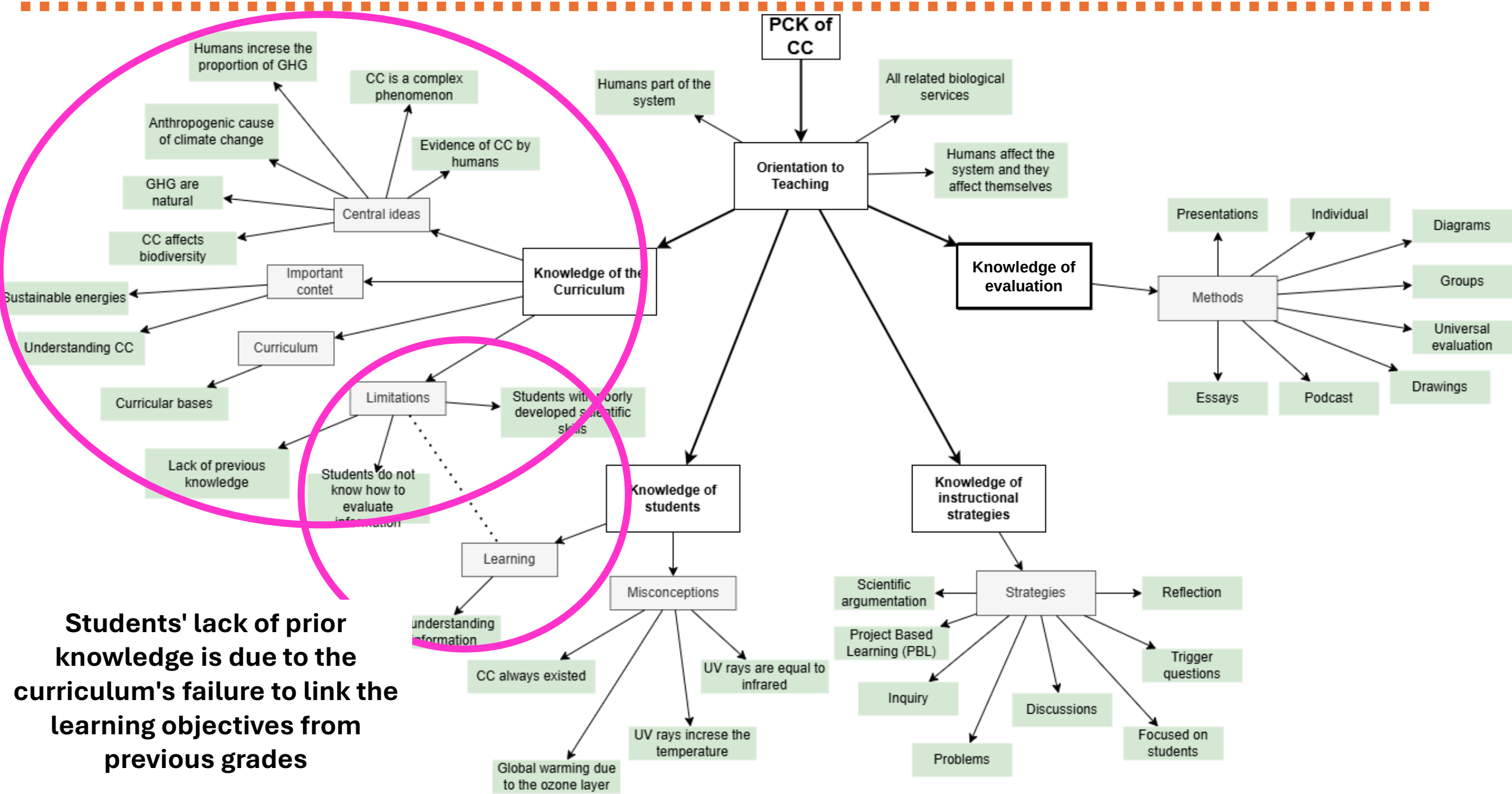
reducing the data by inductively generating codes

Sorted and classified deductive process

Finally, a process of methodological triangulation was carried out in which conclusions were synthesized, integrating both the information from the CoRe interviews, the reflection meetings and the opinion of the teacher Adrián, using the Mixed Model

Results

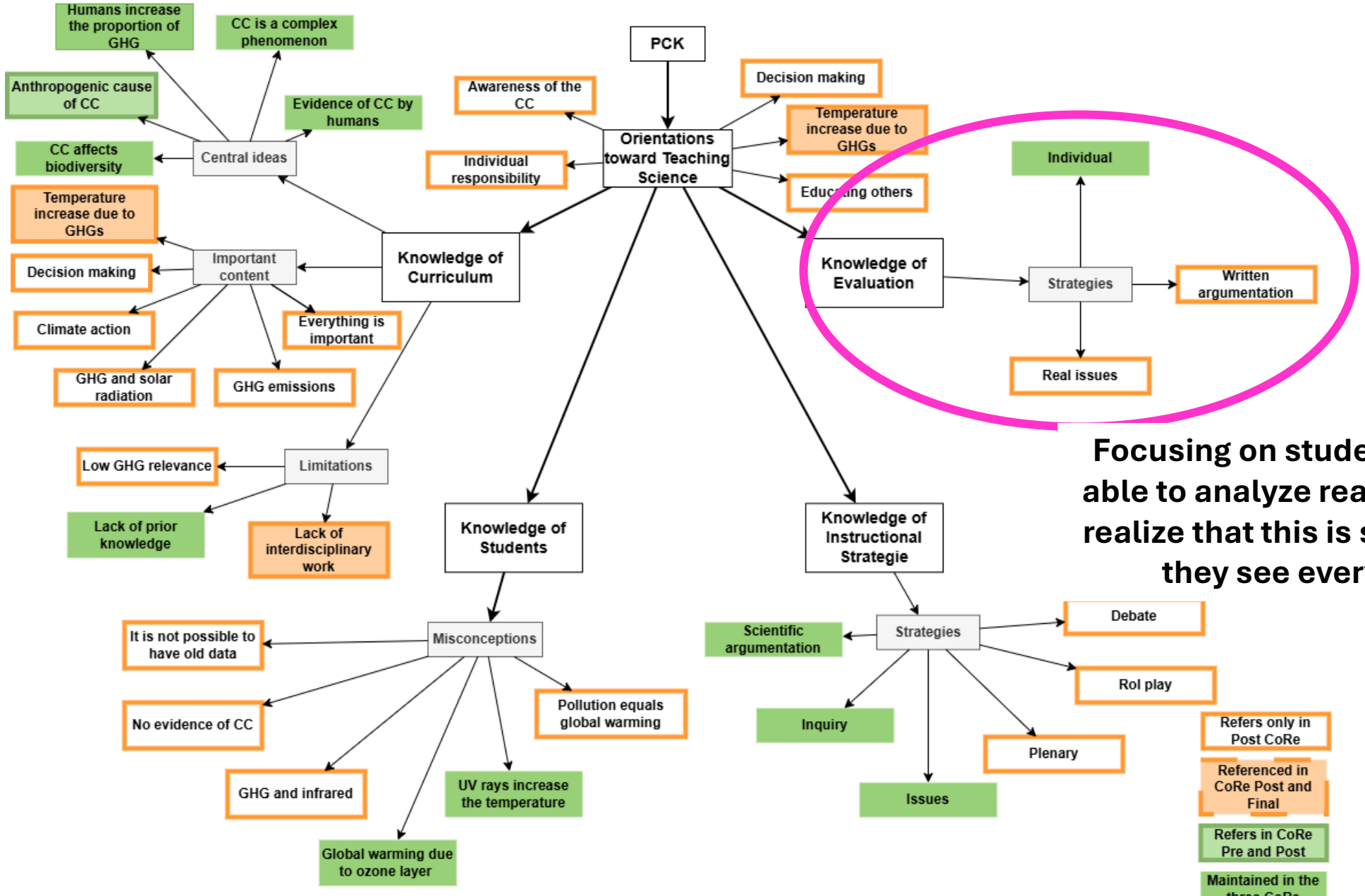
Teacher's map constructed from the first CoRe interview



Students' lack of prior knowledge is due to the curriculum's failure to link the learning objectives from previous grades

Results

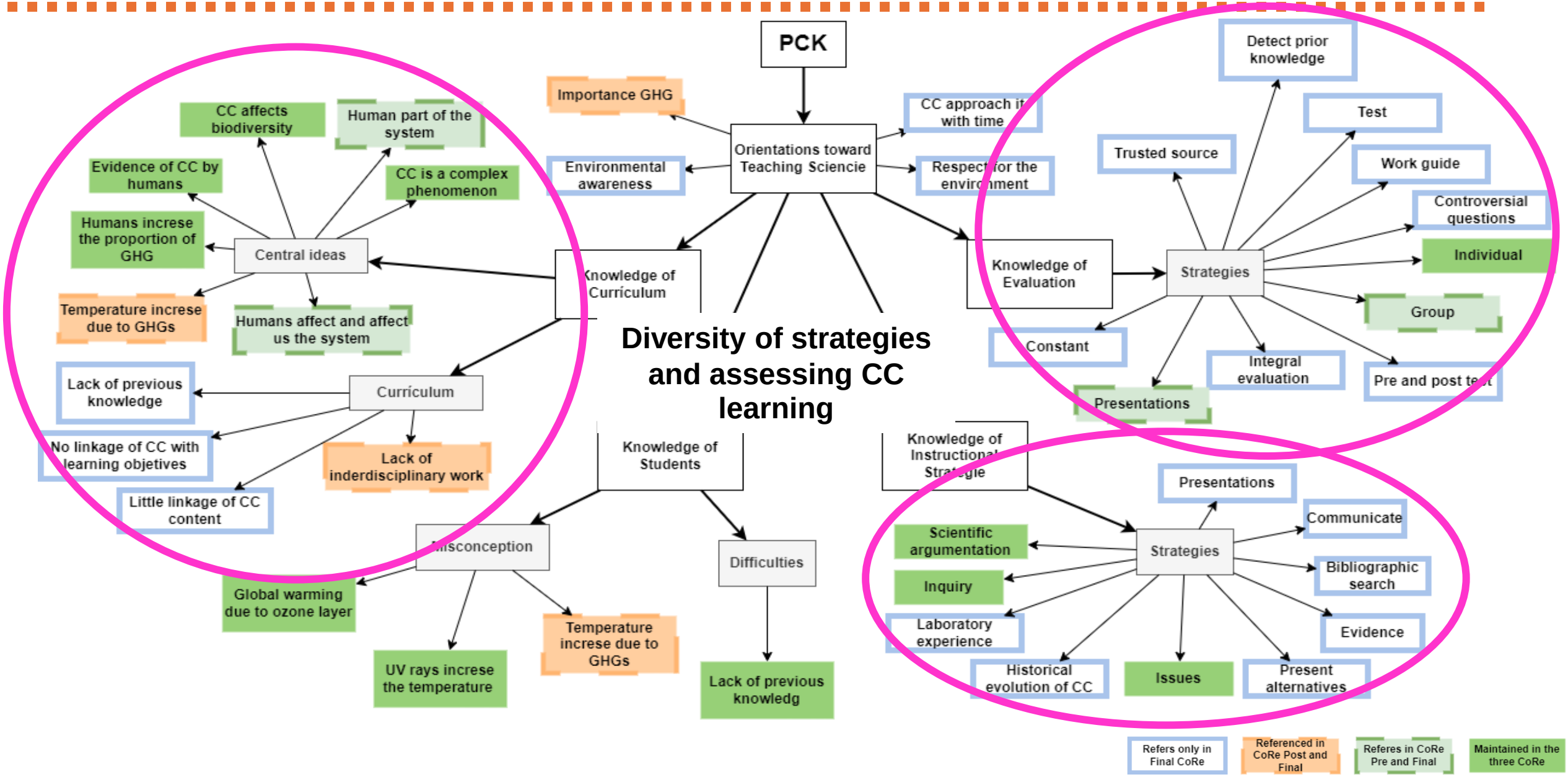
Teacher's map constructed from the second CoRe interview



Focusing on students being able to analyze real cases, to realize that this is something they see every day

Results

Teacher's map constructed from the third CoRe interview



Results

Example of a reflective interview summary on lesson 3 in both teaching sequences

The teacher acknowledges the persistence of certain alternative ideas during both lesson sequences, but he also realizes his improvement in the implementation of the argumentation strategy and his ways of evaluating

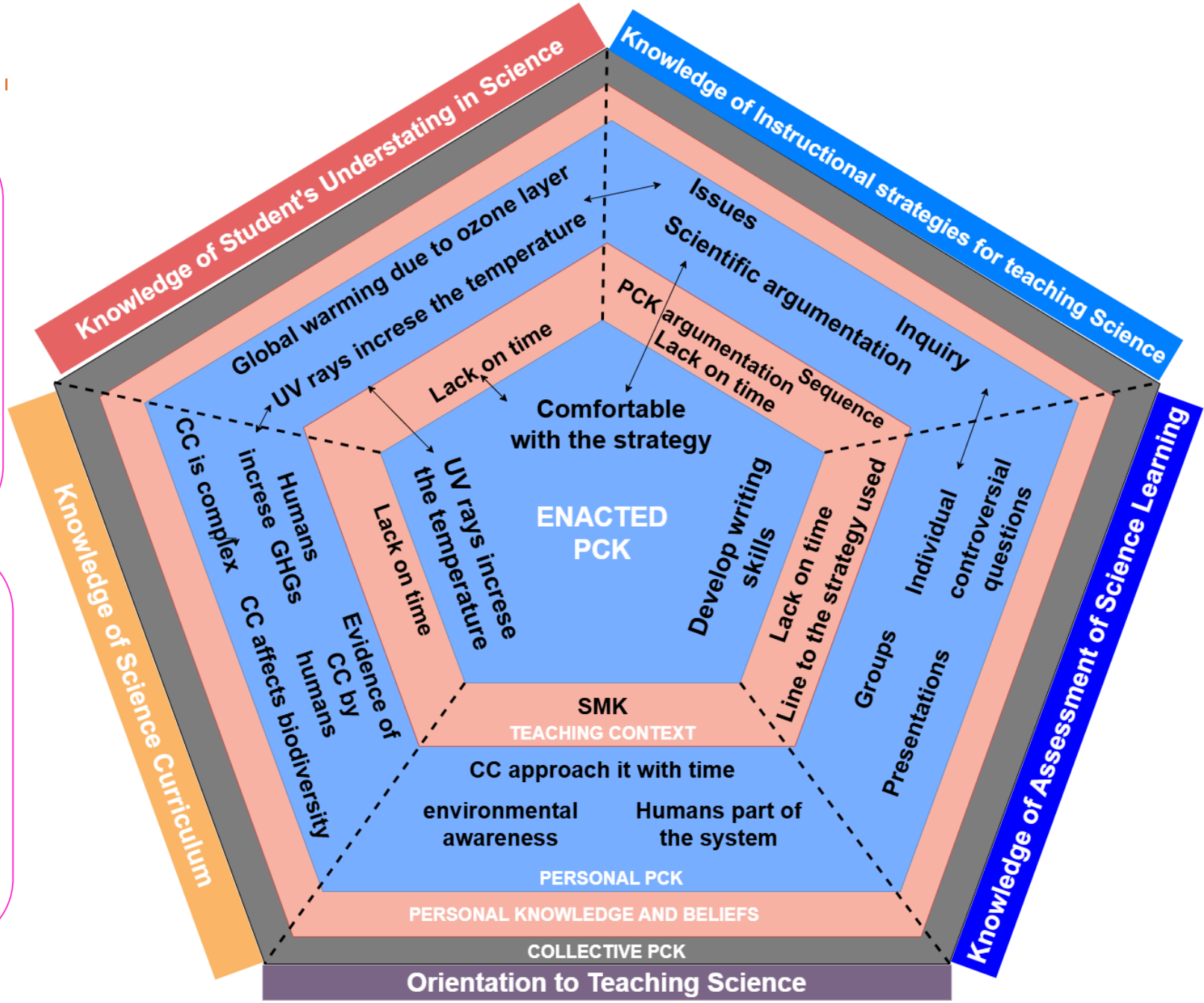
Lesson 3: “Greenhouse effect”	
First sequence of lessons	Teacher Adrian recalls learning centered in two components of PCK: KSU and KIS. Regarding the first, he recognizes the persistence of the preconception of UV rays as responsible for global warming. Regarding the KIS, he points out having learned about 4 aspects: “I must improve the questions in the worksheet”; “I should teach with diagrams”; “the activities in each lesson are connected” and “I must close the lesson with a presentation with central concepts”.
Second sequence of lessons	Teacher Adrian recalls learning centered in KSU and KIS. He states that many students maintain the preconception about the role of the ozone layer in global warming, despite working on it directly in previous lessons. That is something he needs to work again. He recognizes that he was now able to make better choices to stimulate argumentation, unlike the first time he did the lesson, thus reflecting on his ePCK. Therefore, he recognizes the development of his PCK in argumentation as a factor on his ePCKcc.

Results

Triangulation

It can be said that there is evidence that teacher Adrian developed his $pPCK_{CC}$, which is demonstrated by a balanced and diverse structure of its components.

He makes a reflection in which he recognizes different factors (time, SMK of CC and ePCK of argumentation) affecting the ability to transform his $pPCK_{CC}$ to $ePCK_{CC}$.



Discussion and Conclusion

In this study, we described development of PCK of climate change in a biology teacher planning, doing lessons and reflecting about his practice (Park y Oliver, 2008; Alonzo et al., 2019).

During the lessons he realize the persistence of alternative conceptions about the ozone hole and ultraviolet rays (Monroe et al., 2017) and how thethe inclusion of climate change in the science curriculum is a complex thing to address (Salinas et al., 2022; Dillon & Herman 2023; Assaraf et al., 2024).

The teacher realize that some factors such as time, SMK and PCK of argumentation can influence the transition from personal PCK to enacted PCK of climate change (Schiering et al., 2023).

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Thank you for your attention
Any questions?

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