

# Pedagogical Content Knowledge (PCK) of the Nature of Science (NOS): A Preliminary Approach to the Collective PCK of Expert Biology Teachers in Teaching NOS

*SCIENCE EDUCATION FOR THE REST OF US*

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n° 1211920  
n° 1231783

**Paola Núñez, Carolina Parraguez,  
Claudia Vergara y Hernán Cofré**

# Problem

(e. g., Lederman y Lederman 2014; Cofré et al. 2019; Chan y Hume 2019; Mesci et al. 2020; Valencia et al. 2023; Abd-El-Khalick y Lederman 2023; van Driel et al. 2023 )

Understanding the Nature of Science (NOS) is a learning objective in science education.

1

2

Most science teachers and students lack a proper understanding of NOS.

3

4

Gaps in theory and methodology (instruments, longitudinal studies).

5

6

There is still debate on how to characterize the development of PCK.

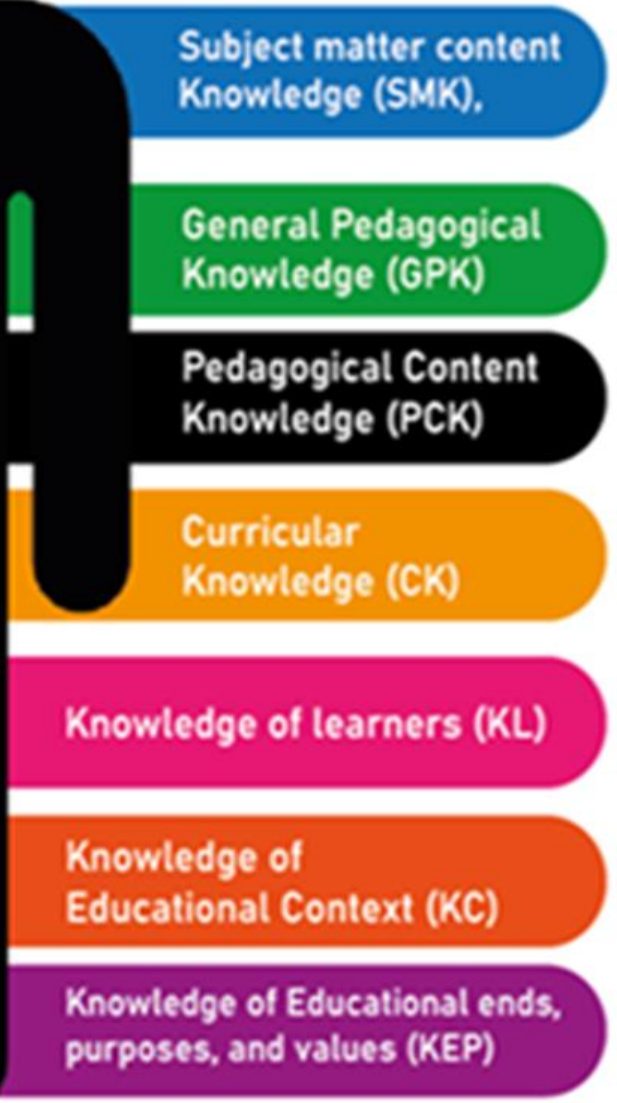
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Researching to understand the various PCKs, in this case, the collective of NOS.

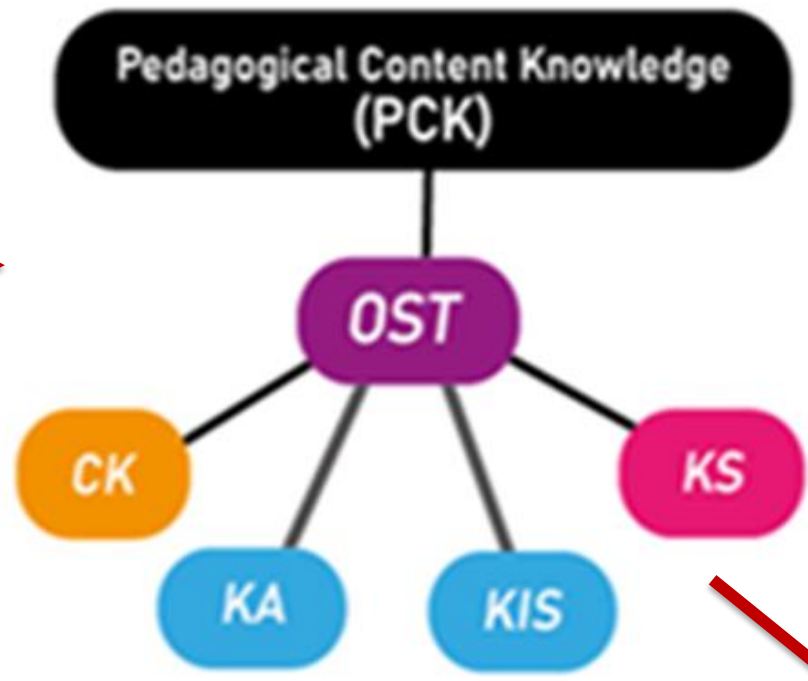
An adequate understanding of NOS by teachers is not a sufficient cause for effective teaching of NOS in the classroom (PCK).

Science teachers develop a high level of understanding of NOS and knowledge of what and how to teach NOS to their students (PCK).

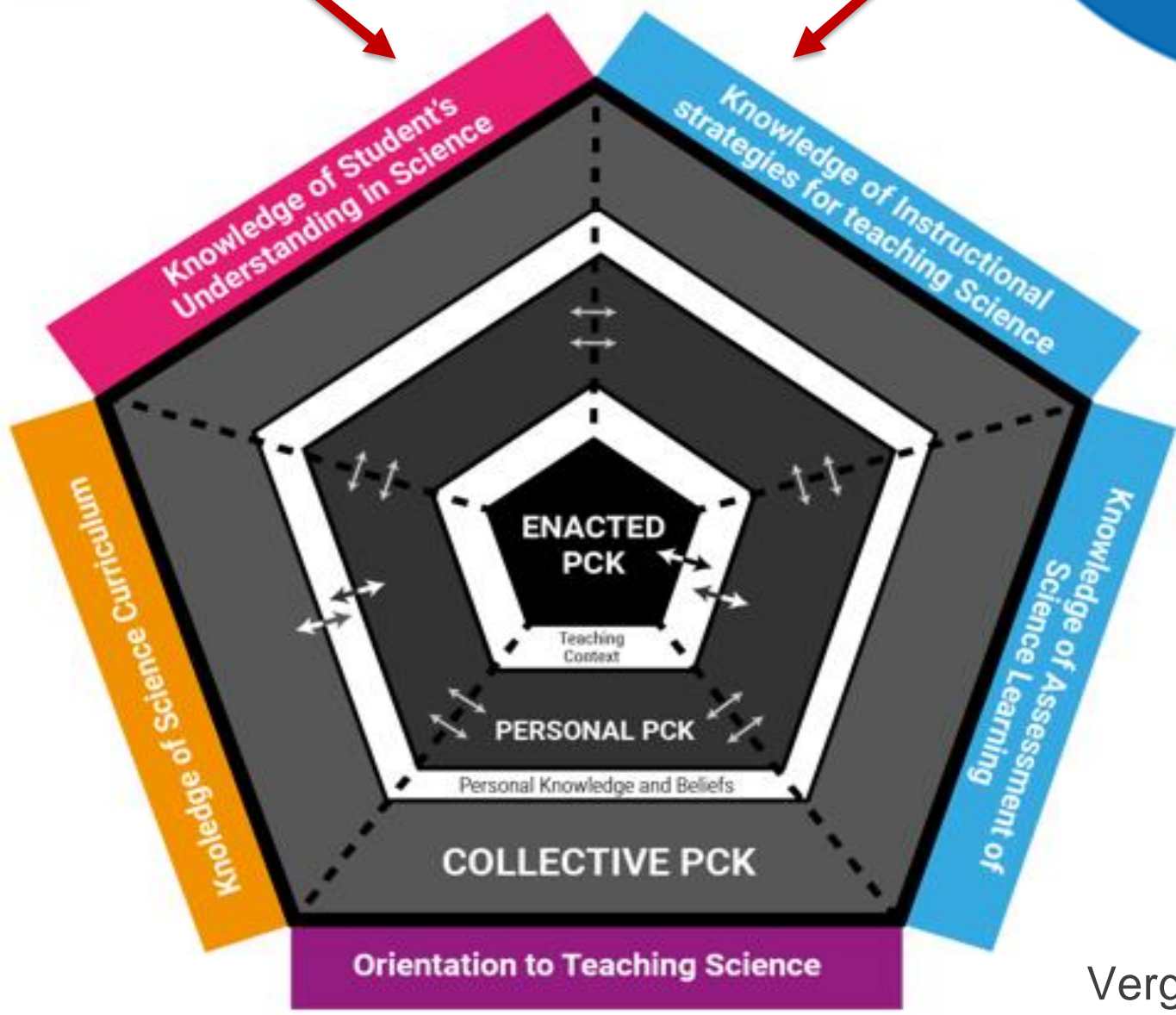
# Shulman (1987)



# Magnusson, Borko, & Krajcik (1999)



# Carlson & Daehler (2019)





What is the collective PCK for NOS of a group of teachers and academics experts in NOS education within the educational context of Chile?

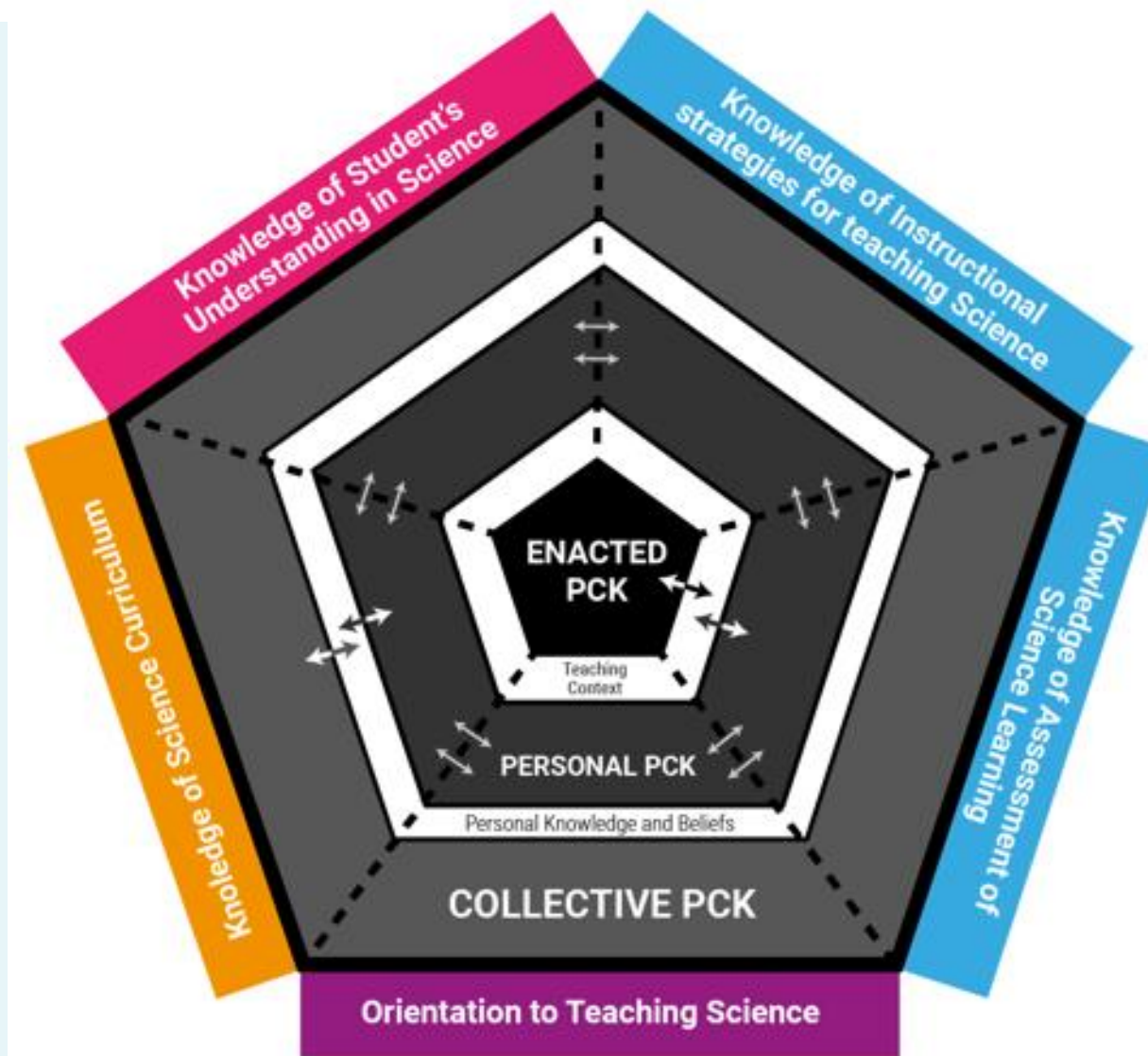


We propose that characterizing this collective PCK for NOS will allow us to compare it with teachers' pedagogical content knowledge for NOS (pPCK for NOS) at different time points, potentially enabling us to assess the change or development of pPCK for NOS over time.

# Theoretical framework

## Pedagogical Content Knowledge (PCK)

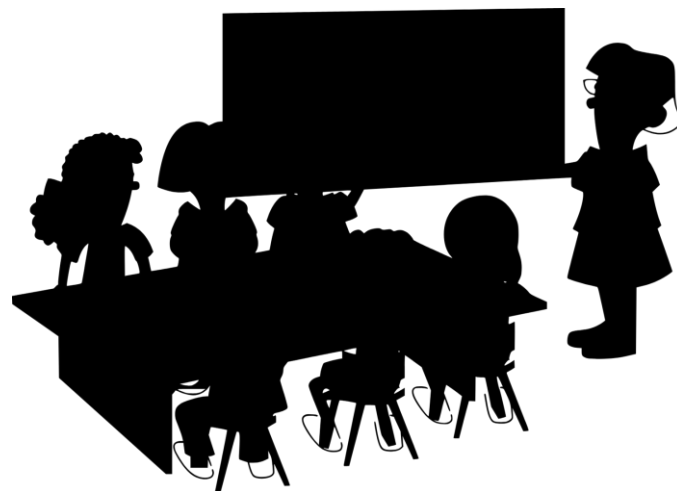
Shulman (1986) "Forms of representation and the construction of the subject matter to make it comprehensible to others".



Vergara et al. 2022

## Nature of Science (NOS)

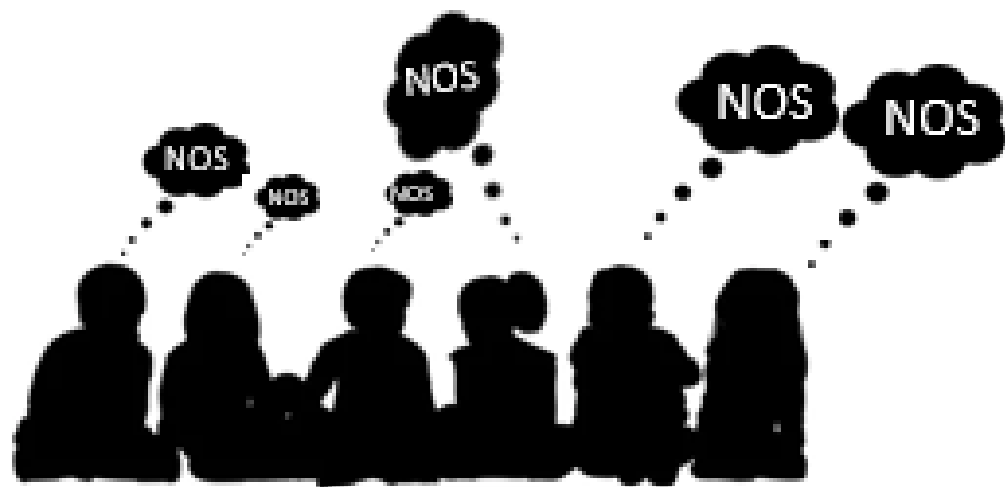
There is agreement on the importance of teaching NOS, despite the underlying discussions about its definition or which aspects to incorporate or not into teaching (Kaya & Erduran, 2016; Abd-El-Khalick & Lederman, 2023; Valencia et al., 2023; and Mesci et al., 2023).



# Theoretical framework

## Pedagogical Content Knowledge of the Nature of Science (PCK NOS)

- "There is a gap in the literature regarding the understanding of the factors that facilitate how a teacher develops knowledge to teach NOS (Mesci et al., 2020).
- "Teachers acquire knowledge about teaching strategies but do not implement them in practice" (Hanuscin, 2013).
- "Limited PCK for NOS in terms of all its components" (Supprakob et al., 2016).
- "There is a need for studies on PCK for NOS with a more comprehensive approach" (Demirdögen et al., 2016).



# Methodology



The study is qualitative in nature with a descriptive approach.

Eight biology teachers participated who have extensive experience as researchers.

The CoRe interview (NOS) was individually administered to each of them.

The categories from Magnusson et al. (1999) were used for the analysis of the interviews.



1  
Eight individual diagrams were generated from the CoRe interviews.

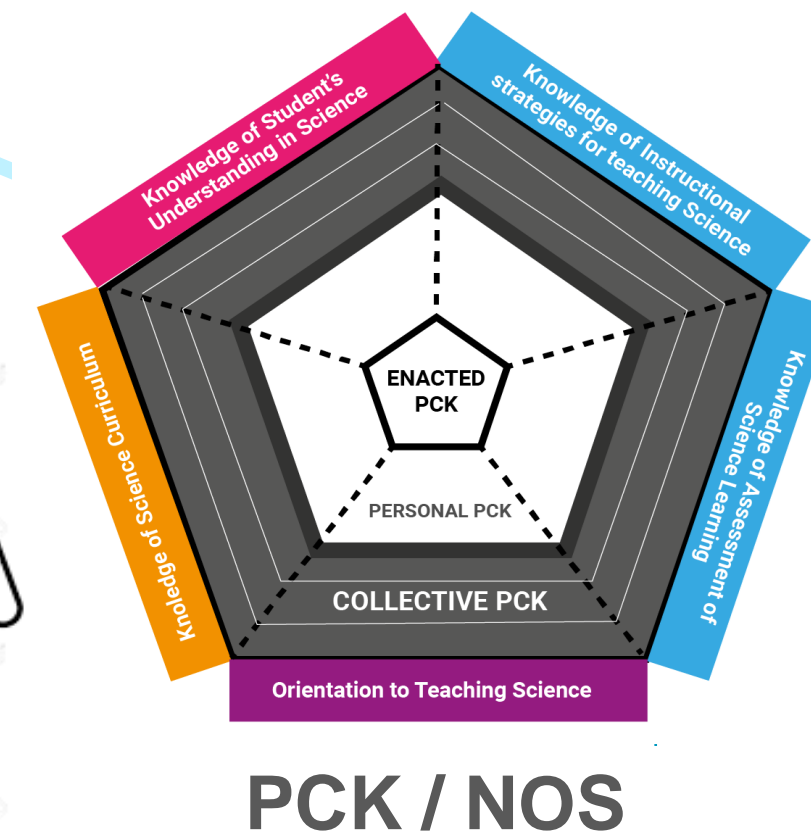
2  
All included codes were integrated into a final diagram of collective PCK for NOS.

3  
Only those codes with a frequency of four or more (50% of the participants) were included in the final diagram.

4  
Finally, the collective PCK of Carlson and Daehler (2019) modified by Vergara et al. (2022) is characterized.

## The step of the methodology

A 'snapshot' of each participant's PCK elements was constructed. To establish the validity of both the coding of each teacher and the final representation of the collective PCK for NOS, only those labels that were coded in the same way by three of the researchers were accepted, achieving a 95% of agreement.





# Results cPCK NOS

The number of codes found, after the consensus process, ranges from 24 to 41 (teacher with the highest number of codes).

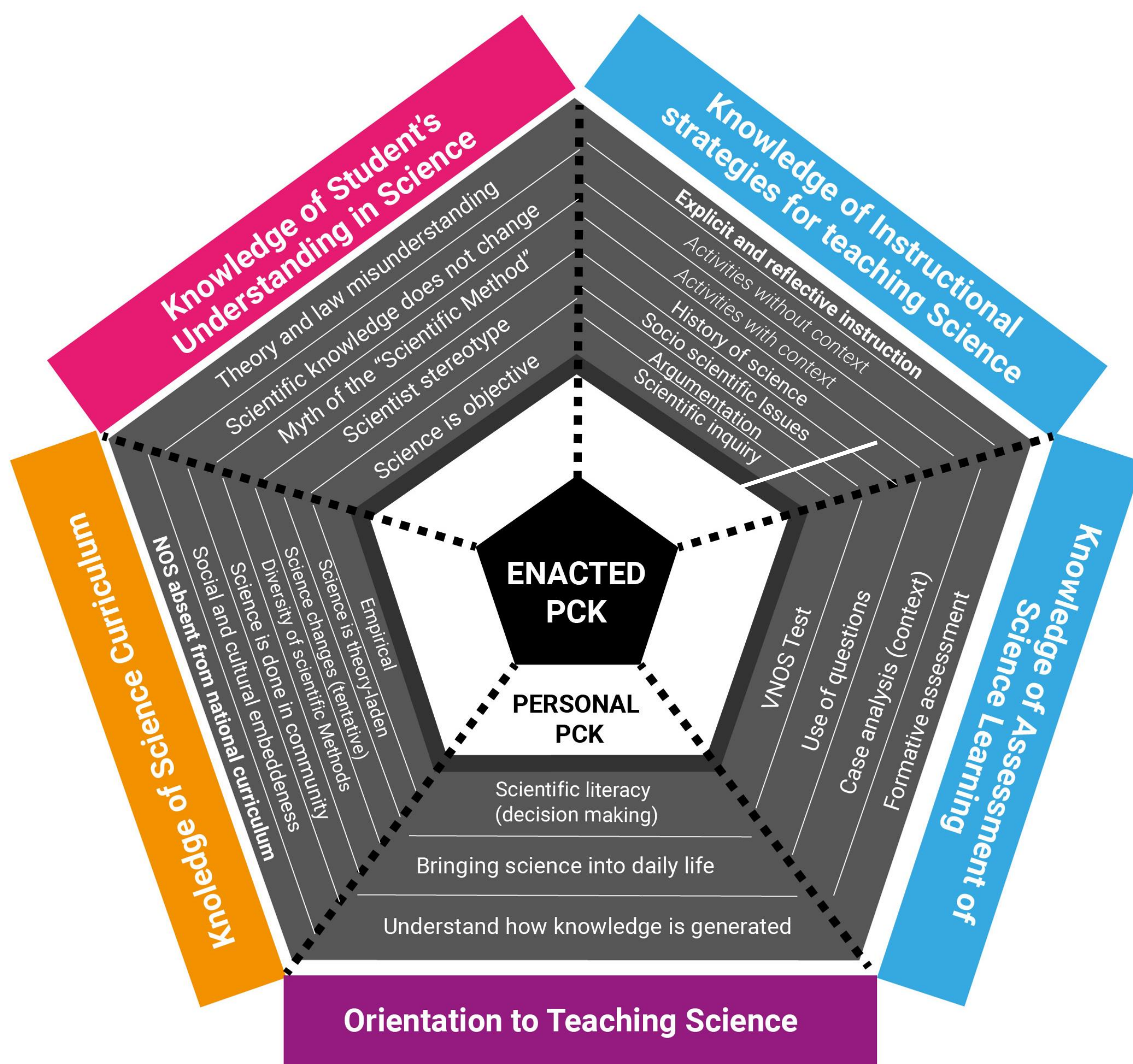
Table 1: Total table of codes for each category (26 codes).

Category	Codes
Orientation to Teaching Science	Understand how knowledge is generated
	Bringing science into daily life
	Scientific literacy
Knowledge of Assessment of Science Learning	Formative assessment
	Case analysis (context)
	Use of questions
	VNOS Test
Knowledge of Student's Understanding in Science	Theory end law misunderstanding
	Scientific knowledge does not change
	Myth of the "scientific method"
	Scientific stereotype
	Science is objective
Knowledge of Science Curriculum	Empirical
	Science is theory-laden
	Science changes (tentative)
	Diversity of scientific Methods
	Science is done in community
	Social and cultural embeddeness
	NOS absent from national curriculum
Knowledge of Instructional Strategies for teaching Science	Explicit and reflective instruction
	Activities without context
	Activities with context
	History of science
	Socio scientific Issues
	Argumentation
	Scientific inquiry

- "In my experience, the thing with students is that when they think about the scientific method, they tend to envision this sequence of steps, where one follows the other, and it's like stages are being completed one after the other, very unidirectional and with highly structured stages of the scientific process." (participant # 4) (f=7)

- "I really like starting with this idea that science is always changing, there's always something new emerging, because I believe that gives them the notion that they can keep doing something new, that they too can keep discovering things, not that everything is already set." (participant # 6) (f=8)

# Results cPCK NOS



- The figure of cPCK was ordered from highest to lowest frequency
- The codes in bold represent codes of a different nature, for example explicit and reflective instruction, it is a teaching approach, that is, it is broader than a strategy. However, the participants recognize it as a strategy. The same thing happens with one of the curriculum codes.

# Discussion and Conclusion

The created cPCK for NOS gathers a set of ideas and knowledge that are in close agreement with the published literature on the teaching and understanding of NOS over the past 30 years (Abd-El-Khalick & Lederman, 2023).

Explicit and reflective teaching is recognized, along with the use of activities with and without context, and some specific strategies such as argumentation or SSI.

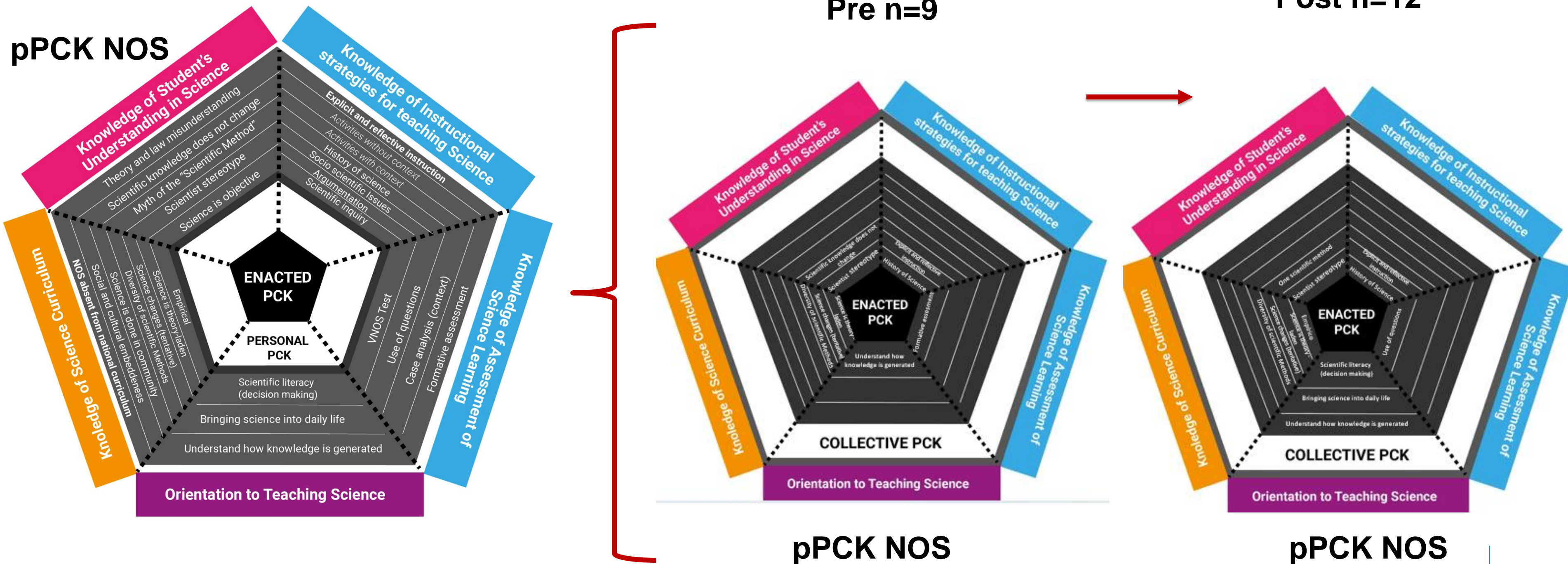
Some of the most described preconceived ideas about NOS (McComas, 1996; Lederman, 2007) are highlighted, and some general aspects of NOS are emphasized as central ideas for teaching.

It can be assumed that those aspects of the general NOS that have not been included in the current cPCK for NOS are less important for the practice and context of these teachers and academics.

The code regarding the idea that scientific knowledge is generated within a scientific community is a central idea to teach, not an individual aspect of the overall view of NOS (Kampourakis, 2016), but it has been recently recognized by Abd-El-Khalick and Lederman (2023).

# Projection

The description of this cPCK for NOS can be an excellent tool for comparing pPCK for NOS in pre-service and in-service teachers, and for evaluating or describing the development of PCK in science teachers.



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Thanks !!

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