PONTIFICIA UNIVERSIDAD CATÓLICA DE VALPARAÍSO

DOCTORADO EN Didáctica de las Ciencias

MDCE

Agencia Nacional de Investigación y Desarrollo
Ministerio de Ciencia, Tecnología, Conocimiento e Innovación
Gobierno de Chile

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Exploring the view of Nature of Science (NOS) and the pedagogical content knowledge (PCK) of NOS in a group of biology teachers before and after a professional development program

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INTRODUCTION

NOS

Nature of science (NOS) is an important component for scientific literacy and even for social justice

(e.g., Osborne et al., 2003; Lederman et al., 2013; Yacoubian & Hansson 2021).

However, numerous research indicates that most science teachers do not possess an adequate understanding of NOS

(e.g., Lederman 2007; Cofré et al. 2019; Zion et al., 2020).

On the other hand, if students are not able to understand the nature of science, teachers must not only improve their understanding of NOS, but also, they must develop their pedagogical content knowledge for NOS

(Hanuscin et al. 2011).

PCK

Despite this, how science teachers develop their PCK for the nature of science is still an underexplored topic in NOS literature

(e.g., Hanuscin, 2013; Akerson et al., 2017; Mesci, 2020; Edgerly et al., 2022).

99 studies reviewed by Chan and Hume (2019) about PCK conducted between 2018 and 2019, only 8 included analysis of NOS PCK.

RESEARCH QUESTIONS

01 How does change the understanding of NOS in a group of Biology teachers participating in a professional development program?

02 How does change the PCK of NOS in a group of Biology teachers participating in a professional development program?

03 Which is the relationship between biology teachers' NOS understanding and their personal PCK of NOS?

METHODS

1

Pretest/Posttest single-group

DESING

2

12 In-service Biology teachers of different regions of Chile, participating of a professional development program (PDP) - which lasted 1 week

CONTEXT

3

- VNOS-D +
- VASI (Question NOS)
- CoRe (Content Represention) NOS

Lederman et al., 2002; 2014
Loughran et al., 2012

DATA COLLECTION

4

- Views of NOS
- **cPCK** NOS /Teachers' **pPCK** NOS change
- VNOS - pPCK

ANALYSIS

Examples VNOS-D+ questions
1. What is the science for you?
What makes science (or scientific disciplines such as physics, biology, etc.) different from other disciplines?
2. Scientists produce scientific knowledge. Do you think that this knowledge can change in the future? Explain your answer and give an example.

Example VASI question
1. Do you consider the research the person did to be scientific? Explain why or why not.

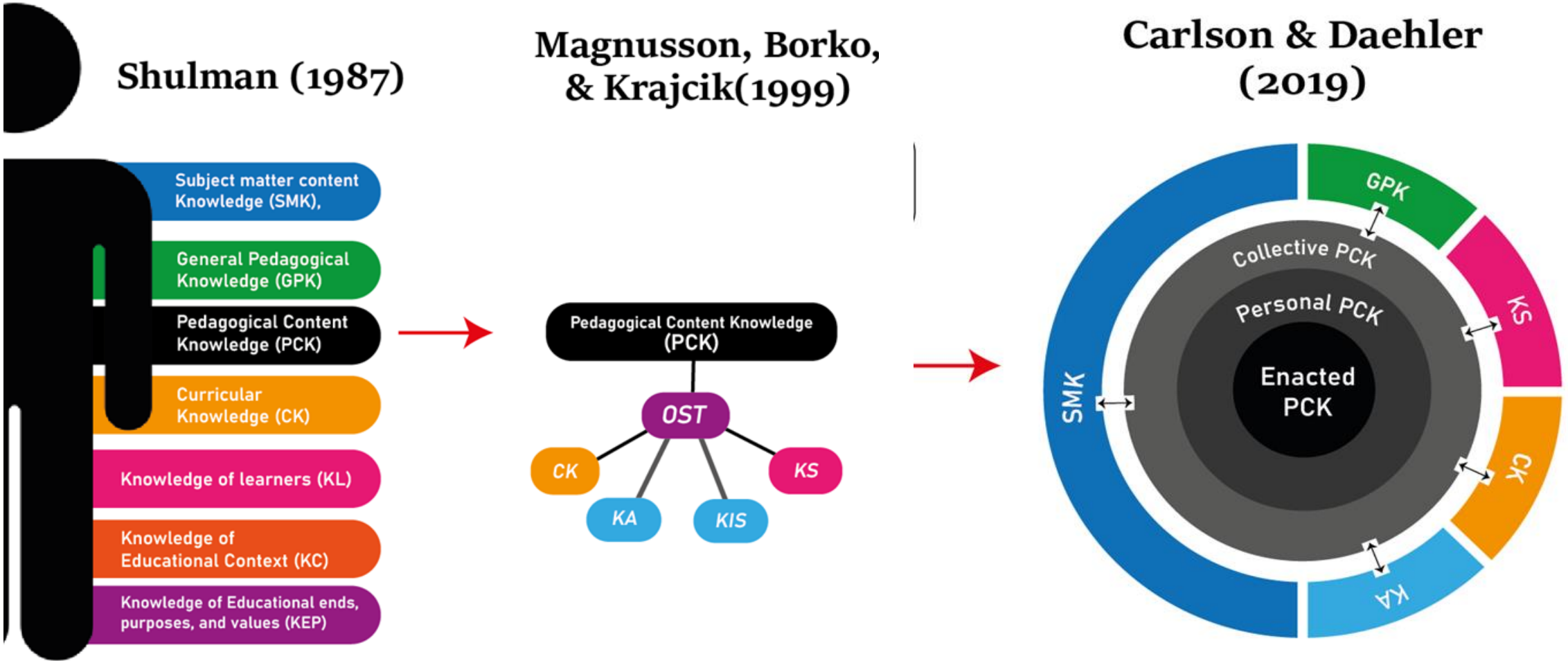
Examples CoRe questions
1 What is the central or most important idea that you hope your future students will learn in relation to NOS?
2. Why is it important for your future students to learn from NOS?

VIEW OF NOS - Q1

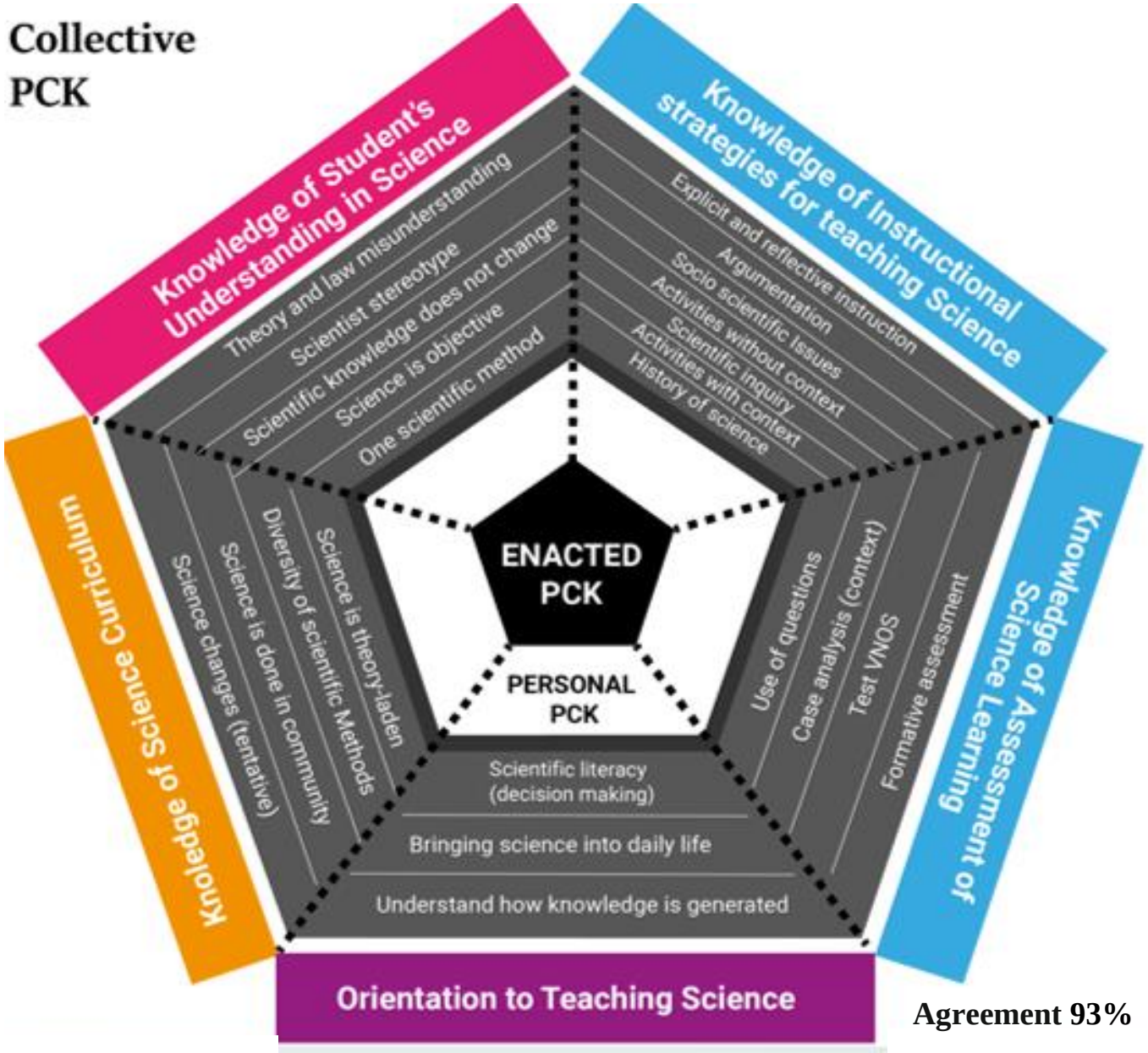
- The creation of a profile for each participant according to their understanding of NOS, by current literature in three levels: **informed, mixed, and naïve** (quantitative analysis value 1, 2 and 3)
  (e.g., Authors 2016; Mulvey & Bell, 2017; Mesci et al., 2020).
- For each biology teacher, answers of each of the 8 studied aspects of NOS were coded independently by two researchers using a rubric.
- 95% agreement was recorded between the review of both researchers and the total number of disagreements were settled with a third researcher.
- To generate a quantitative analysis, a variable of NOS understanding was created (scored between 0 – 24). To assess the change in total view of NOS before and after the PDP a *Wilcoxon test* was used.

PCK CHANGE – Q2

Here we show the main models on PCK from Shulman to the Refined Consensus Model. The colors indicate the different knowledge identified in each model. In this study we created a new PCK model (The mixed model) based onthe five subcomponent of Magnusson et al., (1999) model and the three realm of PCK in Carlson & Dahler (2019) theoretical framework.



cPCK NOS– Q2



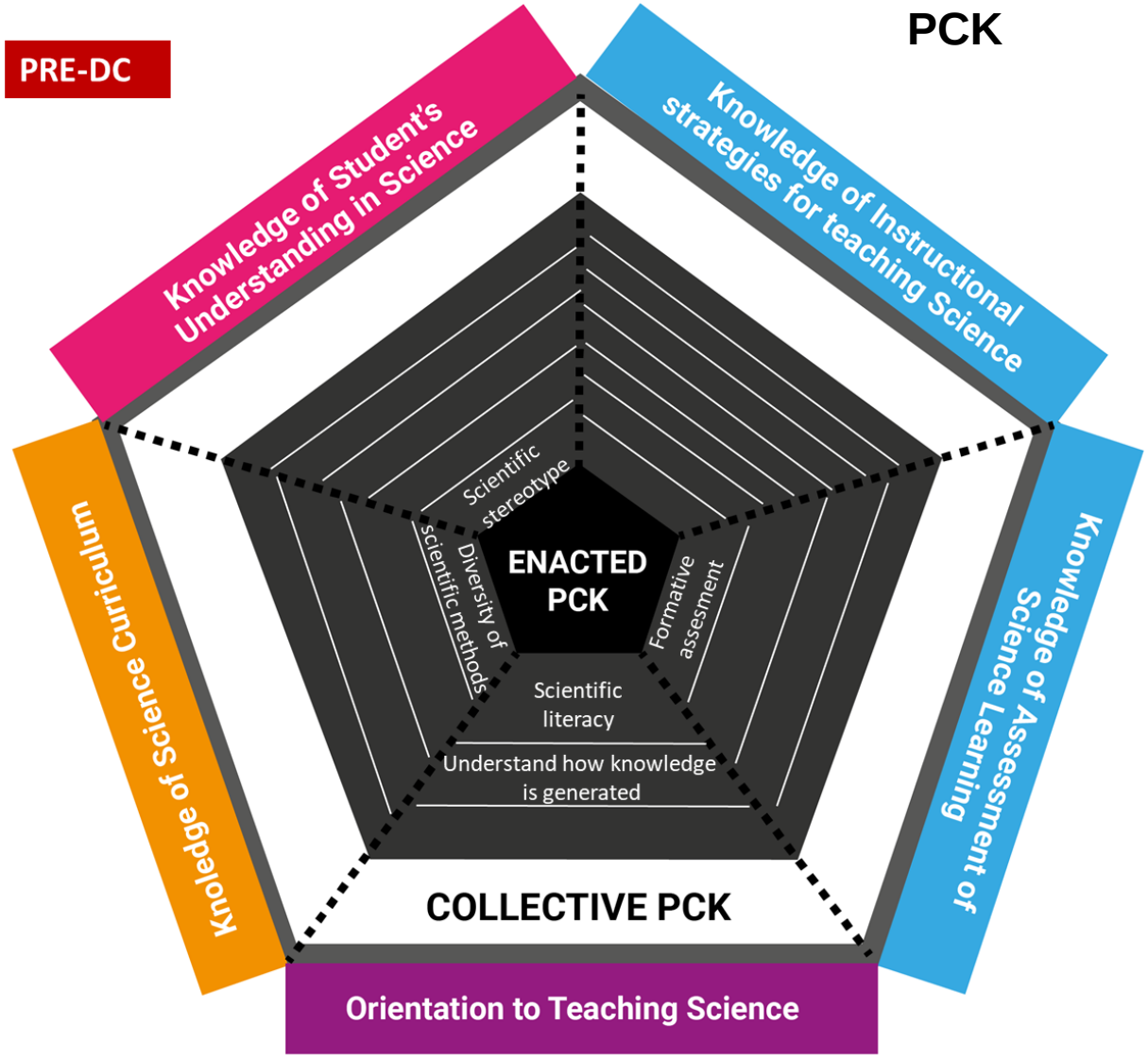
Agreement 93%

- To generate the collective PCK of NOS, a CoRe interview was applied to **8 experts**: 4 academic professors with extensive experience in teaching and researching NOS and 4 classroom teachers who have contributed to courses and PDP on NOS and NOS teaching.
- The CoRe were then transcribed and coded using the deductive categories of Magnusson et al 1999.
- Finally, the frequencies of the codes that were mentioned were recorded and those with 4 or more mentions were included in the final model.

pPCK NOS – Q2

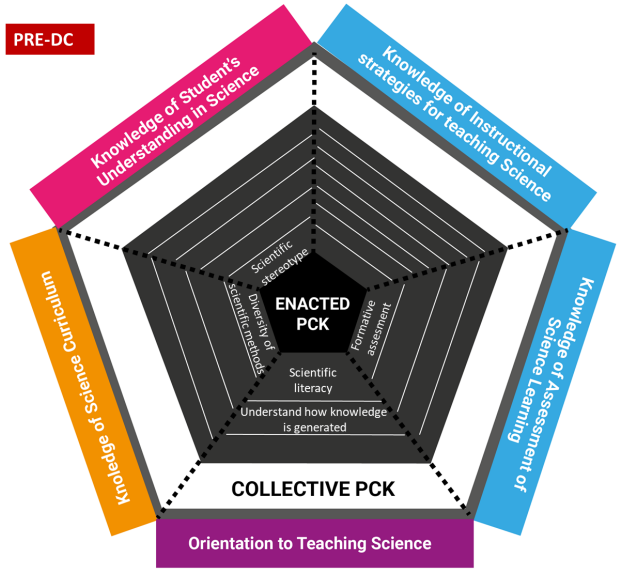
- The personal PCK of NOS will be presented for each participating PDP biology teacher. A Core Pre and a CoRe Post were applied.
- **The transcription and coding** of each CoRe was carried out through an inductive coding process, obtaining emergent codes.
- **The codes were validated by 2 researchers** and a personal pre and post NOS PCK was obtained for each biology teacher based on the collective NOS PCK.
- The comparison was carried out according to three main characteristics of the pPCK diagram: **I) Changes in the total area II) Changes in the shape of the diagram III) Changes in the identity codes**

Personal PCK



RELATIONSHIP BETWEEN VIEW AND pPCK of NOS – Q3

For study the relationship between NOS view and pPCK of NOS of biology teachers, a spearman correlation (r) was calculate between two quatitative variables: total score of View of NOS of each biology teachers and total codes of personal PCK of NOS by biology teachers included in the collective PCK of NOS.

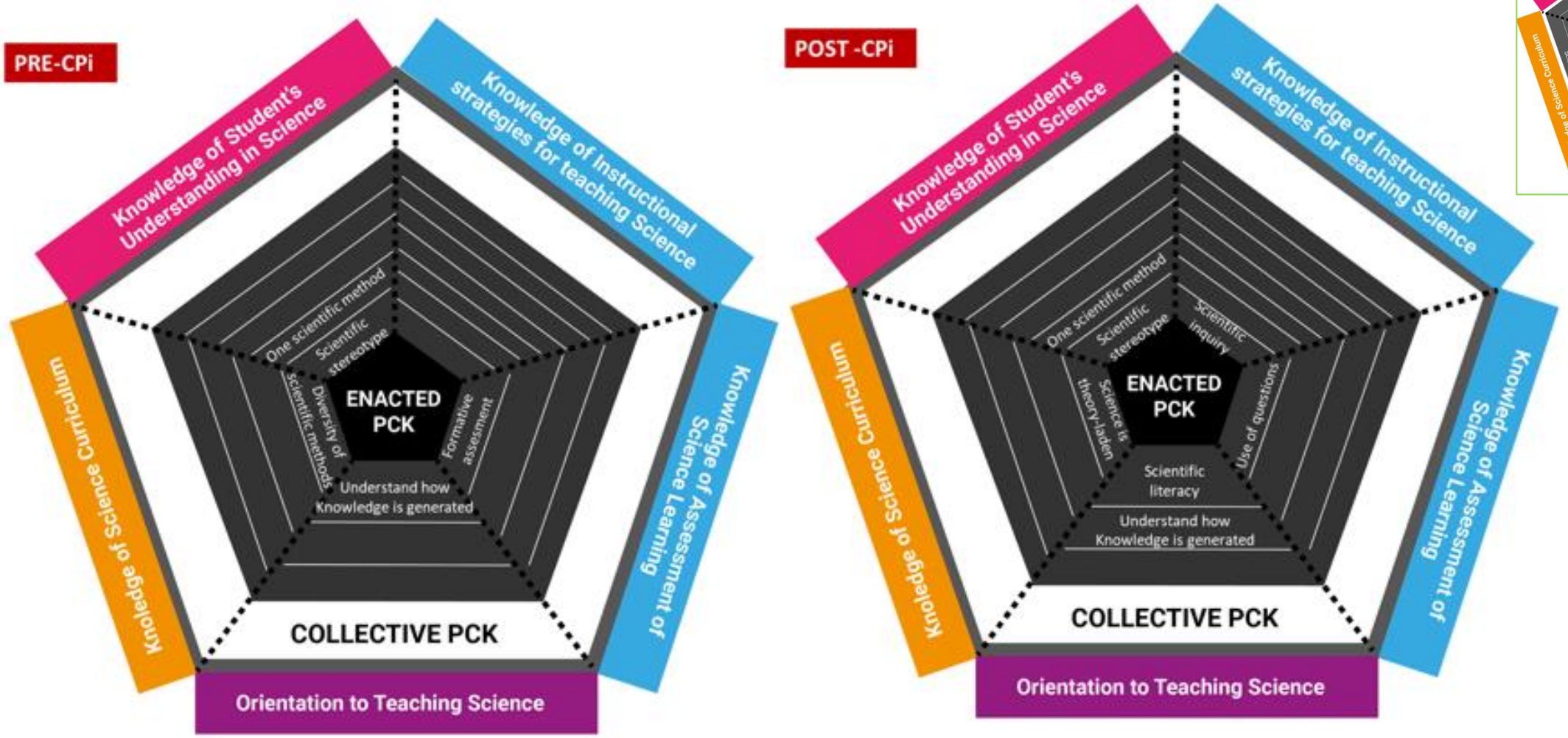


RESULTS VIEW OF NOS - Q1

NOS ASPECTS	PRE-TEST			POST-TEST		
	NAIVE	MIX	INFORMED	NAIVE	MIX	INFORMED
EMPIRICAL	0	4	8	0	0	12
TENTATIVE	1	5	6	0	8	4
INFERENTIAL	4	6	2	3	2	7
THEORY-LADEN	3	5	4	1	4	7
CREATIVE	0	1	11	0	1	11
THEORY AND LAW	1	6	5	0	3	9
SOCIAL AND CULTURAL	1	5	6	0	3	9
NO SINGLE METHODS	2	4	6	0	2	10

Table 1: After the PDP the teachers improved in several of the most difficult aspects of NOS understanding (e.g**., Theory & law and Sociocultural)** Furthermore, according to the ***Wilcoxon test*** significant differences were obtained between the total score of NOS in the pre and post-tests (z = -2,14; p<0,05; **mean=19,31** [pre-test] and **mean =21,31** [post-test].

RESULTS pPCK NOS – Q2



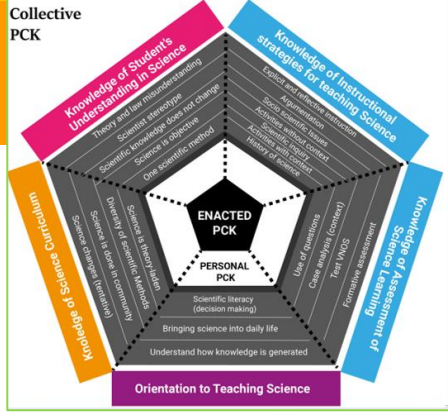


Figure 2. Example of teacher' **change in shapes** (e.g strategies component), **change in area** (increased of 5 to 7 component) and **change in composition** (new codes= scientific inquiry, Scientific literacy, and codes intechanges) of her pPCK of NOS through the comparison of her CoRe pre and CoRe post with the cPCK of NOS.

RESULTS pPCK NOS – Q2

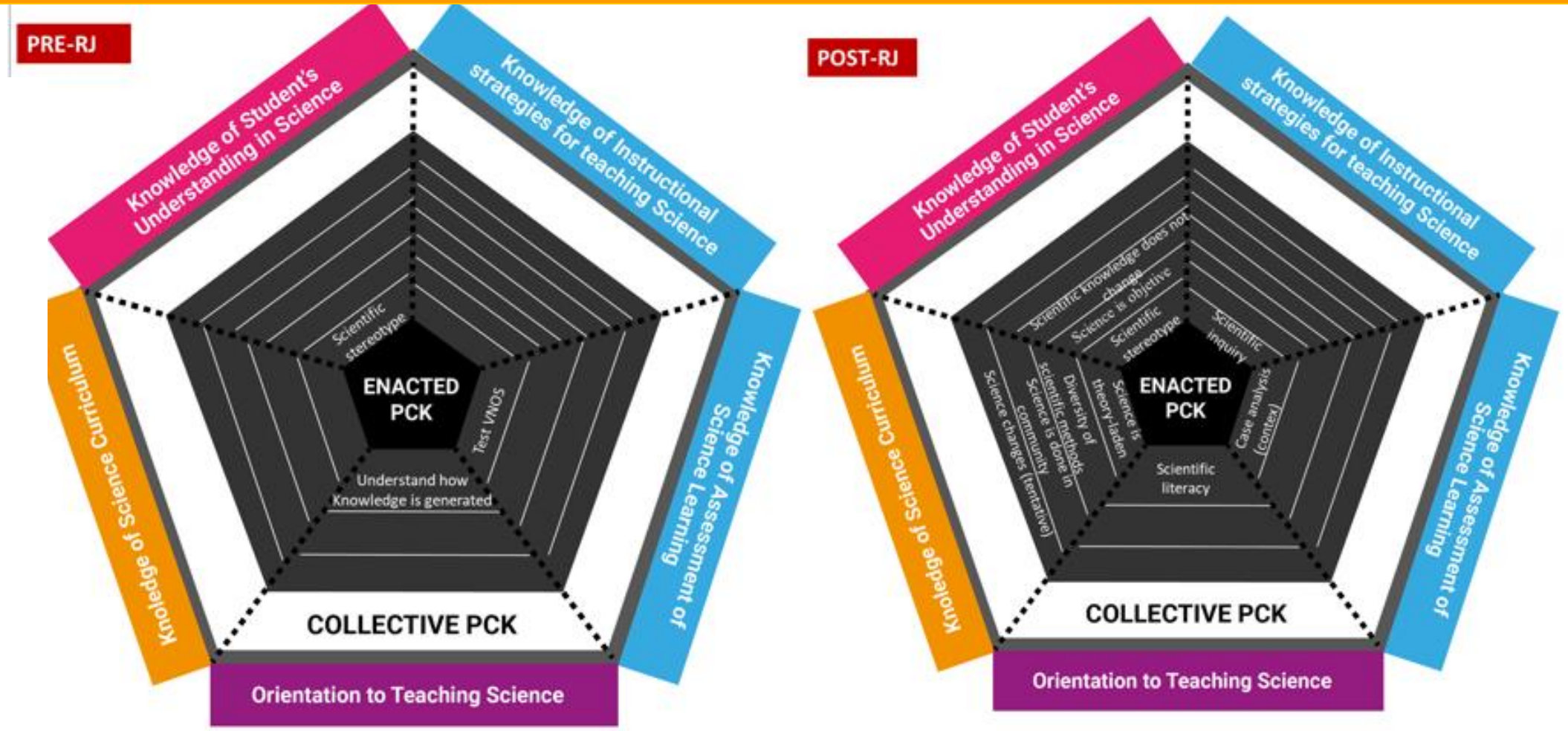
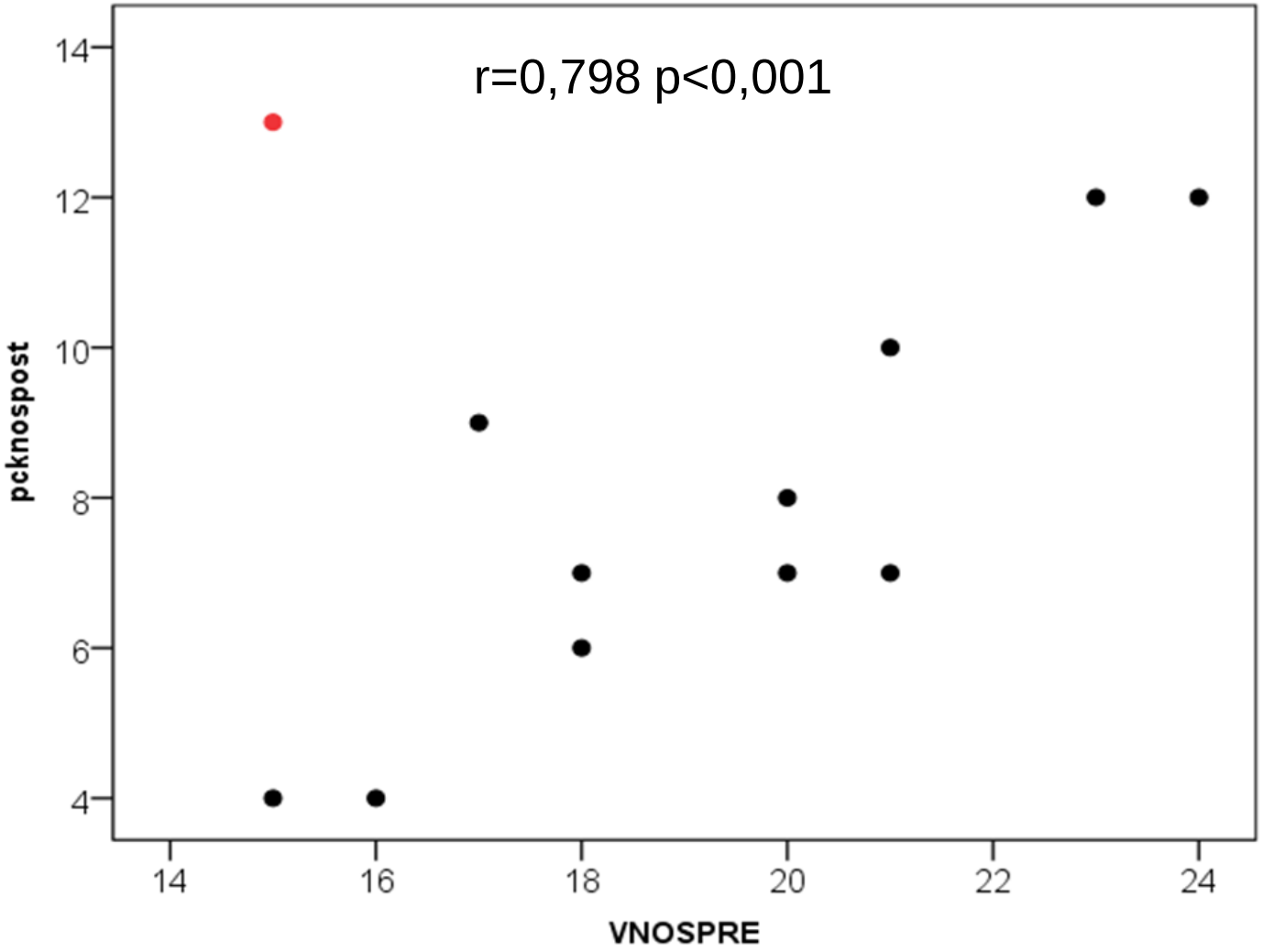


Figure 3. Example of teacher' **change in shapes** (e.g strategies, curriculum and student knowledge component), **change in area** (increased of 3 to 10 component) and **change in composition** (new codes=diversity of scientific methods in the curriculum or science is objective in the student knowledge component and other codes that change for others such as VNOS test and case analysis.

RESULTS CORRELATION PCK/VNOS – Q3



In general, teachers with less knowledge of NOS improved more than teachers with more informed views at the beginning, except for one teacher who performed very differently from group (outlier) . When subtracted she from the analysis, a positive and significant correlation can be observed between the teachers' initial NOS view and their final NOS PCK.

	VNOSPOST	VNOS GAIN	PCK PRE	PCK POST	PCK NOS GAIN
VNOS PRE	0,501	-0,803	0,361	0,798**	0,713*

DISCUSSION

Before the intervention, there are several aspects in which teachers are very informed (e.g., empirical). This can be explained because 8 of 12 teachers had previous experience with NOS either in their initial or in-service training, which would account for a long-term retention of participants' post-intervention understanding of NOS (Mulvey & Bell, 2017; Yacoubian 2021).

Changes in total area: Most of the 12 biology teachers PCK of NOS increased in total area due to the increase the number of cPCK of NOS concepts in their post CoRes, after the program.

Changes in diagram shape: The shape of pPCK of NOS in each biology teachers, increase mostly due to the subcomponents of students understanding and instructional strategies. Assessment is the least developed component. In this study, unlike previous literature findings (e.g., Park & Oliver 2012). orientation was a well-developed component of PCK of NOS.

Changes in codes identity: Some of the cPCK of NOS concepts that more frequently appear were: teaching NOS by HOB and argumentation; Core ideas to learn about no single methods in science and scientific knowledge change in time; alternative conceptions of “the scientific method”; theory become laws; and scientific knowledge do not change.

CONCLUSIONS

This study allows considering the cPCK as an effective tool to describe the development of teachers' pPCK, which allows comparing and recognizing the most relevant aspects of the PCK of the teachers studied.

The results allow conclude that the PDP is an opportunity for teachers to reflect on their practice, which is related to a change in the view of NOS and, in a lower extent, in the PCK NOS (Cofré et al, 2019).

Likewise, this is visualized when comparing the results between teachers who have participated in PDP of NOS and those who have not, since the former are characterized by presenting a better understanding of NOS and a greater area of aspects in their PCK (Mulvey & Bell, 2017).

Finally, these results confirm what other studies have found in terms of the complex relationship between NOS understanding and its teaching (e.g., Lederman 1999; Hanuscin 2013; Wahbeh & Abd- El-Khalick, 2014).

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Thanks !

Any questions ?

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