Building the Conceptual Profile of Chemical Analysis: The Sociocultural Domain

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Overview

1. Introduction
2. Theoretical framework
3. Purpose
4. Methodology
5. Results
6. Conclusions

Introduction

Heterogeneity in thinking

(Cooper, Kouyoumdjian & Underwood 2016, Caspari, Kranz & Graulich 2018)

Challenge for teaching & learning

(Talanquer, 2019)

Conceptual Profile Framework

(Mortimer, Scott & El-Hani, 2012)

SCIENTIFIC THINKING

CHEMICAL THINKING

(Sevian & Talanquer, 2014)

Synthesis

Analysis

(Skoog, Holler & Crough, 2007)

Transformation

Conceptual Profile Framework

Zones: specific ways of thinking about a given concept.

(Mortimer, Scott, do Amaral & El-Hani, 2014)

Foundation 1

For a given concept heterogeneity in thinking is found in the **population**

Foundation 2

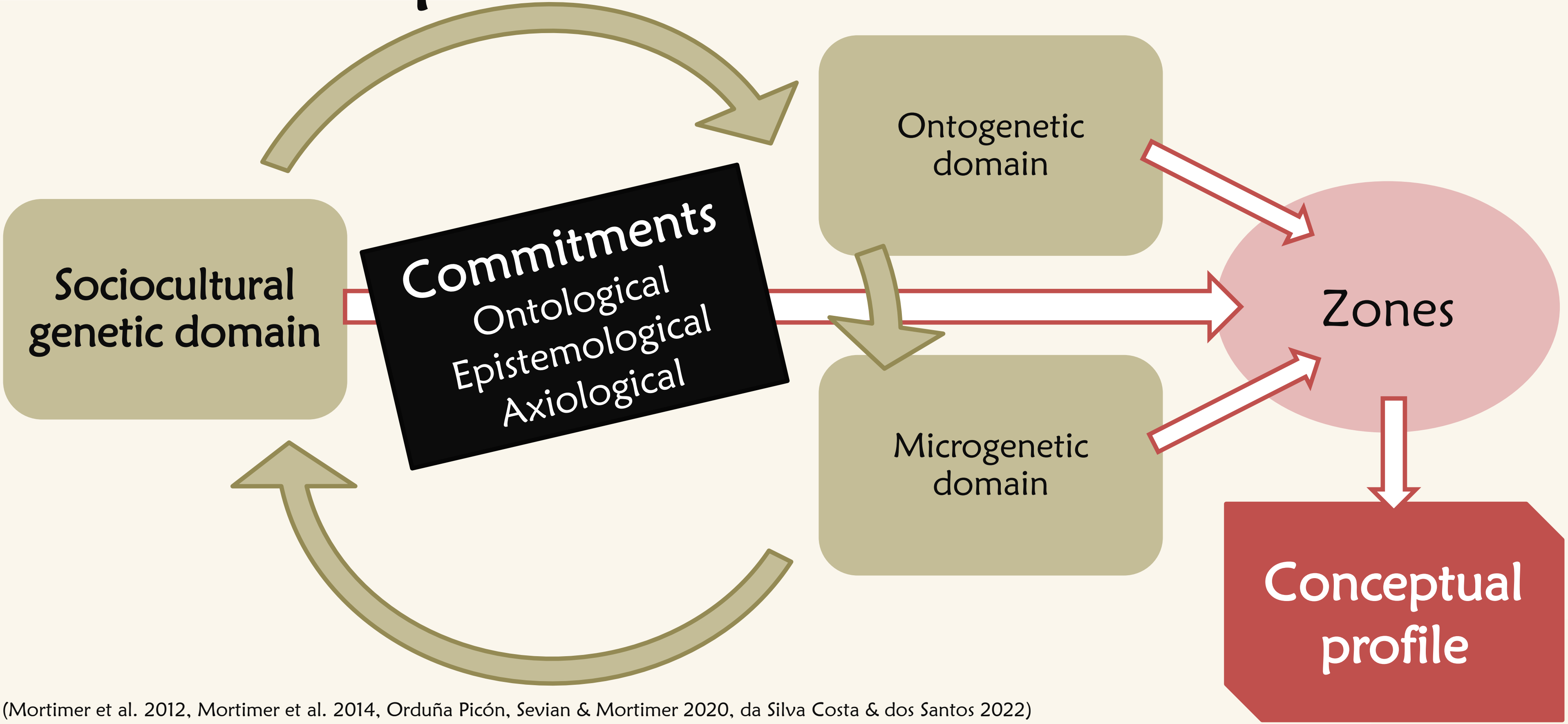
For a given concept heterogeneity in thinking is found in an **individual**

Foundation 3

Modes of thinking and modes of speaking are considered as equivalent

(Mortimer et al. 2014, da Silva Costa & dos Santos 2022)

Conceptual Profile Framework



(Mortimer et al. 2012, Mortimer et al. 2014, Orduña Picón, Sevian & Mortimer 2020, da Silva Costa & dos Santos 2022)

Conceptual Profile Framework

Students learn scientific ideas

Students' conceptual profiles are enriched

The relative importance of each zone changes

Students become aware of how distinct ways of thinking differ from each other

Students are trained to choose the appropriate way of thinking for each context

Metacognitive process

(Mortimer, Scott & El-Hani 2012, El-Hani, da Silva-Filho & Mortimer 2013)

Purpose

Chemical analysis is:

- **central concept** in Chemistry (Sevian & Talanquer, 2014) and in science in general,
- used in **science contexts** as well as in **everyday language.**

The conceptual profile of chemical analysis:

- has not been developed,
- has been needed as an **alternative means of assessing students' understanding** about chemical analysis (Tan, Goh, Chia & Treagust, 2002).

The purpose of this study is the development of the **conceptual profile of chemical analysis** within the sociocultural genetic domain.

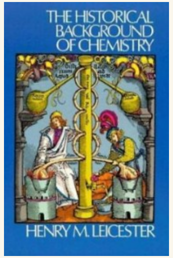
Methodology

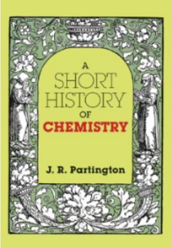
Sociocultural genetic domain

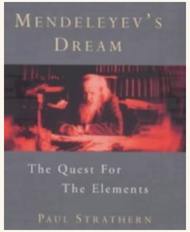
- secondary literature on the **history** of science
- **epistemological** and **philosophical** sources

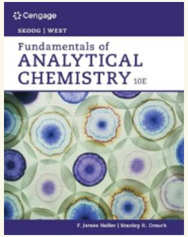
(Thompson 1999,
Tan, Goh, Chia & Treagust 2002,
Karayannis & Efstathiou 2012)

TEXTBOOKS



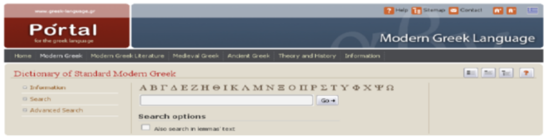


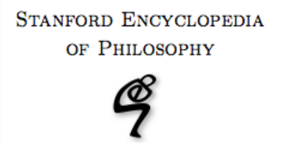




(Leicester 1971, Partington 1989, Strathern 2000, Skoog, Holler & Crouch 2007)

DICTIONARIES





(Dictionary of Standard Modern Greek, Stanford Encyclopedia of Philosophy)

Methodology

Commitments

Ontological

- What **kind of entities/processes** does an individual commit to believe exist to make sense about what chemical analysis is?

Epistemological

- What is **the basis on which a person justifies** her/his belief that particular entities/processes exist to make sense about what chemical analysis is?

Axiological

- What **evaluative–affective judgments** does an individual make to construct her/his relationships with entities/process to make sense about what chemical analysis is?

(Orduña Picón, Sevian & Mortimer, 2020)

1. Everyday practices

Ontological	• simple practices of **isolation** and **separation** of substances
Epistemological	• **direct observation - use of senses**, instinct, skill, practice, experience, independently of theory
Axiological	• use for **daily and professional** needs

2. Alchemist analysis

Ontological	• simple practices of **isolation**, **separation** and **purity control** of substances
Epistemological	• **direct observation - use of senses**, instinct, skill, practice, experience, modifying or independently of theory
Axiological	• **metaphysical - mystical - supernatural - philosophical** background, profit, fraud, suspicions

3. Empirical techniques

Ontological	• simple experiments - **titrimetric** and **gravimetric** techniques
Epistemological	• **direct observation - use of senses**, instinct, skill, practice, experience, little use of theory
Axiological	• **logical thinking**, accuracy, generalizations, breakdown of events into components

4. Classical analysis

Ontological	• **titrimetric** and **gravimetric** techniques
Epistemological	• experiments based on **physical properties** and **chemical reactions**, comprehensive theoretical framework, publications
Axiological	• **systematic** analysis, similarities – differences and grouping, **repeatability**, verification, **errors**, comprehensible records and results, **accuracy** of the analysis and reduction of analysis time

5. Classical instrumental analysis

Ontological	• **instrumental techniques** (isolated instruments in the laboratory)
Epistemological	• experiments based on **physicochemical properties**, comparison of the **signal of samples and standards**
Axiological	• reduction of cost and time of analysis, **non-destructive** methods, **low detection limits**

6. Contemporary tool for society

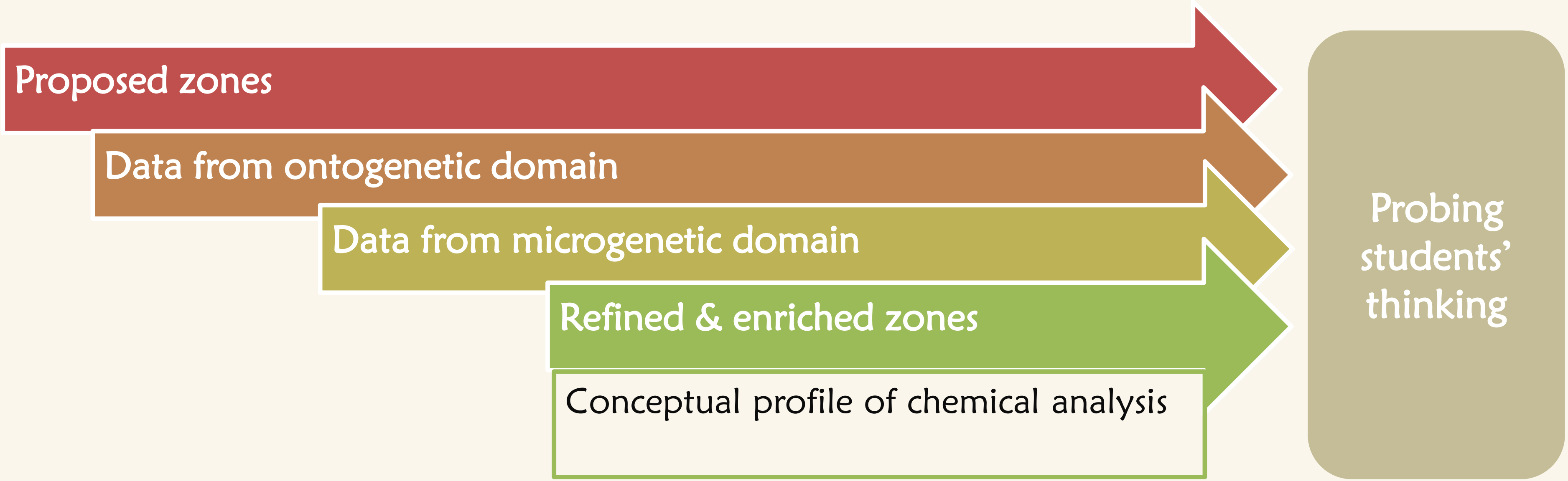
Ontological	• **instrumental techniques** (coupled instruments in the laboratory or in field work)
Epistemological	• development of **chemometrics** and **other related scientific fields**
Axiological	• **socio-economic dimension and R&D**, **specialization**, collaboration, minimization of error, larger numbers of data and **multidimensional information**, lower detection limits, reduction of cost – time of analysis, reliability, **automation**, **sensitivity**, **selectivity** and **optimization**

Conclusions

Chemical analysis

1. Everyday practices
2. Alchemist analysis
3. Empirical techniques
4. Classical analysis
5. Classical instrumental analysis
6. Contemporary tool for society

Next…



(Mortimer et al. 2014, da Silva Costa & dos Santos 2022)

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Thank you!