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Freie Universität Berlin

Differentiation of the Family Resemblance Approach to Nature of Science

Theoretical Background & Research Question

FRA to NOS
(Erduran & Dagher, 2014)

Differentiated FRA to NOS (Reinisch & Fricke, 2022)

Cognitive-epistemic system of science
Scientific Practices:
Observing, Experimenting, Comparing and Classifying, Modeling

Knowledge:
Hypotheses, Theories, Models, Rules

Social-institutional system of science
Scientific Ethos:
Respect of Research Objects, Respect for the Environment, Protection of Human Subjects, Confidentiality, Communalism, Legality

Discipline specificities for biology:

Errors in experiments can be traced back to the variability of living beings as research objects (Bässler, 1991)

"Not all sciences may have laws" (Irzik & Nola, 2011, p. 600)

Which NOS aspects can be justified as discipline-general and which as biology-specific?

Methods: Expert Interview Study

Criteria based sample selection (e.g., professorship in the respective discipline, successful third-party funding application)

Guided interviews (Gläser & Laudel, 2010)

"Please assess the characteristics of experimenting in biology, in comparison to chemistry or physics."

Tab. 1. Sample (*N*=22)

Discipline		*N*
Biology	Cell Biology	2
	Genetics	2
	Evolution	2
Chemistry	Anorganic Chemistry	2
	Organic Chemistry	2
	Theoretical Chemistry	2
Physics	Experimental Physics	4
	Theoretical Physics	2
Philosophy	Philosophy of Science	3
Education	Science Education, research focus: FRA	1

Content structuring analysis including inductive coding (Mayring, 2015)

Communicative validation process (Bryman, 2016)

Results: Aspects of Experimenting

It is described that during experimenting, …

Other disciplines of the natural sciences will **also** formulate hypotheses and conduct experiments to **examine the hypotheses**. (P2, Cell Biologist, 4-35)
→ … hypotheses are examined.

The difference in the experimental design of **biological experiments compared to chemical or physical experiments** is that **organisms** always stand in the centre. Perhaps these are somewhat more **complicated systems** overall, and perhaps partly more expensive systems. (P3, Geneticist, 185-200)
→ … the experimental design is oriented on specificities of the research object (e.g., organisms as complex systems).

In biology, we have the problem of the **variation** in the basic set and therefore we often work with **probabilities** in the explanations or with **statistical methods**. These also exist **in physics** but **play a lesser role** there because laws of nature are much better understood. (P6, Evolutionary Biologist, 126-153)
→ … probabilities, statistical methods, and laws or rules are considered due to specificities of the research object (e.g., variability).

References

Bässler (1991) *[Error and knowledge]*
Bryman (2016) *Social research methods*
Erduran & Dagher (2014) *Reconceptualizing the NOS for science education*
Irzik & Nola (2011) A FRA to the NOS for science education
Gläser & Laudel (2010) *[Expert interviews and qualitative content analysis]*
Kampourakis (2016) The "general aspects" conceptualization
Lederman & Lederman (2014) Research on teaching and learning of NOS
Mayring (2015) *Qualitative content analysis*
Reinisch & Fricke (2022) Broadening a NOS conceptualization

Discussion & Conclusion

Biology-specific features of experimenting: alignment of design and interpretation towards **living beings** as research objects (see Bässler, 1991)

Discipline specificities of individual NOS aspects can be used to design NOS **learning pathways** along a continuum (Kampourakis, 2016)

How to analyze data from experts who refer to a scientific discipline outside of their own expertise?

To what extent can results be generalized?

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