Teacher professional development on properties of matter in primary education

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Abstract. The interdisciplinary nature of science education often leads to a focus on observing phenomena, neglecting to take care of the epistemic aspects and the acquisition of awareness of basic methodologies. Among these aspects are the properties of matter, their measurement, and their role in physics laws. Our proposal for this study focuses on the application of a mixed model EL-CP-ES to build competence in a group of primary teachers of the properties of matter, in order to recognize their role in physics laws. The context is a teacher net, which every year organizes a professional development activity on science education.

Introduction and theoretical framework

Scientific education from the earliest levels of schooling is considered a challenge both by a large research community [1]. The interdisciplinary nature of science education often leads to a focus on observing phenomena, neglecting to take care of the epistemic aspects and the acquisition of awareness of basic methodologies. Among these aspects are the properties of matter, their measurement, and their role in physics laws. Primary teachers require research based support for:

i. Conceptual understanding: [2];
ii. Pedagogical knowledge [3];
iii. Confidence and motivation to be able to encourage student engagement [4].

To address these needs various models are proposed in literature, the main are: 1) metacultural and experiential learning [5, 6], 2) communities of practice [7], 3) expert support that is valuable for teachers [8].

This study has the character of action-research in which a model of teacher education on properties of matter is implemented, aiming to build the epistemic character of physics in primary education.

Research

By means of our research methods in building educational proposals [9], starting from the educational reconstruction of basic conceptual ideas and a literature review of the main difficulties in learning this topics, we developed a Teacher Professional Development (TPD) proposal focuses on the application of a mixed model EL-CP-ES to build competence in a group of 23 primary teachers of the properties of matter. A test in-out was prepared to have evidence of the properties of matter familiar and tought by teacher in their praxis before and after TPD. In addition we analysed the planned and implemented activities by teachers in their classroom after the TPD intervention module, where the research based educational proposal are explorative inquiry based activities on the following topics: mass, volume, area, length, density, solubility, elasticity, refractive index, specific heat, state change temperature, thermal and electrical conductivity, electropositivity, magnetic properties and a reflection on what are system, substance and state properties.

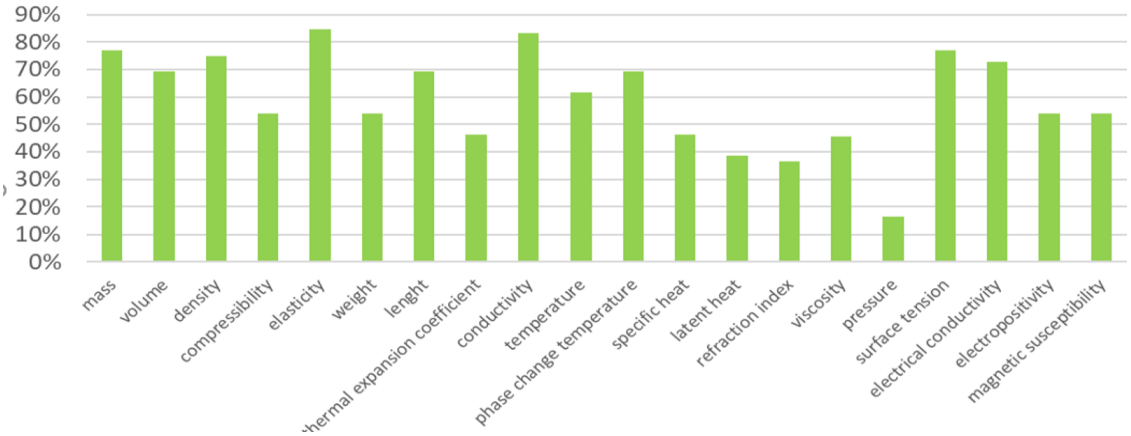
Research questions

RQ1. How sort of formative needs do teachers have with respect to the properties of matter?
RQ2. How the implemented EL, CP, ES modalities is most useful to teachers?
RQ3. How sort of impact did the activities have on classroom work?

Findings

Test-in made it possible answer to RQ1 in particular for what concern content, conceptual aspects. Figure 1 show, for example how teacher in test-in consider properties of matter even state properties and processes. Our observations and test-out allowed us to respond to RQ2. The analysis of the activities carried out in class allowed us to answer RQ3 and complete the answers to the other RQs. The results of this multi-perspective study will be presented.

Fig.1 – Properties of matter listed by teachers in test-in



References

[1] G. DeBoer, *A history of ideas in science education*, Teachers College Press, 2019.

[2] K. C. Margot, T. Kettler, Teachers' perception of STEM integration and education: a systematic literature review, *International Journal of STEM education* **6**(1) (20019) 1-16.

[3] G. V. Caprara, C. Barbaranelli, P. Steca, P. S. Malone, Teachers' self-efficacy beliefs as determinants of job satisfaction and students' academic achievement: A study at the school level, *Journal of School Psychology* **44**(6) (2006) 473–490.

[4] T. R. Kelley, J. G. Knowles, J. D. Holland, J. Han, Increasing high school teachers self-efficacy for integrated STEM instruction through a collaborative community of practice. *International Journal of STEM Education* **7**(1) (2020).

[5] M. Michelini, Dialogue on Primary, Secondary and University Pre-service Teacher Education in Physics. In: Guisasola J., Zuza K. (eds) *Research and Innovation in Physics Education: Two Sides of the Same Coin. Challenges in Physics Education*. Springer, Cham, 2020.

[6] J. Seaman, M. Brown, J. Quay, The evolution of experiential learning theory: Tracing lines of research in the JEE. *Journal of Experiential Education* **40** (2017) NP1–NP21.

[7] K. H. Au, Communities of practice: Engagement, imagination, and alignment in research on teacher education, *Journal of teacher education* **53**(3) 222-227.

[8] P. Hudson, Specific mentoring: A theory and model for developing primary science teaching practices. European journal of teacher education **27**(2) (2004) 139-146.

[9] M. Michelini, L. Santi, A. Stefanel, M. Chiofalo, Entangled research methods for the building of coherent conceptual thematic learning paths and connecting research with praxis, *IL NUOVO CIMENTO* **46** C (2023) 196, DOI 10.1393/ncc/i2023-23196-4 Colloquia: IPER 2022.