Physics teachers' professional development: longitudinal training for building coherent curricula across grades

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Abstract. A relevant part of Physics Education Research is devoted to identifying, searching, and designing processes for implementing professional training development. Among them, the greatest attention focuses on secondary education, somehow in higher and less on primary education. Instead of fragmented scenarios for different grades, we developed a longitudinal training experience engaging Physics teachers from different instruction levels to participate in a huge community of practices. Belonging to this community, teachers reflect and develop *new* habits of mind and practices when they adopt the ISLE approach in their classrooms. Here, we report the main features and outcomes of the training process.

Introduction and theoretical framework

We are facing global changes which need prepared citizens to understand complex situations. This will happen if education systems acquire new reference models to prepare learners to live and work in a complex and connected society [1]. At every level of instruction, from early childhood to higher education, teachers in the 21st century should prepare themselves for forthcoming challenges that impact student learning, a difficult task because many of these challenges remain unidentified [1]. For these reasons, professional development yields a significant impact [2]. Teachers should be continuously engaged in experiences of in-service training programs [3], better if it happens in a community of practices [1, 2, 4, 5, 6, 7]. Communities are learning environments where teachers collaborate, reflect, and improve their knowledge and expertise [2, 3, 7].

As a theoretical framework for teachers' programs, we referred to DHAC (Development of Habits through Apprenticeship in a Community) [4, 5], embracing its adoption for in-service professional improvements. Developing a longitudinal training experience in the Italian context of instruction, we are testing that this framework is suitable for physics teachers in high secondary education [6] and, as we are now experimenting in other grades, including teachers with no physics-specific background in their former training. Our training program would try to answer the research question of whether the DHAC framework allows all grade teachers to develop *new* productive habits when trained to implement the ISLE (Investigative Science Learning Environment) approach [8, 9] in their classroom activities. Adopting longitudinal professional development, we are investigating building a coherent ISLE-based curriculum [8].

Method and Implementation

During the last two academic years (22/23 and the current 23/24 – data reported until now), we engaged teachers from different instruction levels in our training program (Table 1). These teachers constitute the sample for investigating the use of the DHAC for longitudinal professional development and building coherent conceptual curricula. Table 1 reported how many teachers got involved in workshops, which featured one aspect of the training program. Tutoring, coaching and reflecting are the other components shaping all training. Each phase of the DHAC helps us collect data (mainly through brief surveys and interviews) to profile teachers' changing habits, looking at their dispositions, knowledge and skills towards Physics teaching [4]. We tried to measure the change using the *teaching gain* tool [10].

Table 1. Workshops and teachers' engagement during the two academic years.

	Early Childhood, Primary and Low secondary education		**High secondary education**	
A.A.	# teachers	# workshops	# teachers	# workshops
2022/23	25	3	80	11
2023/24	160	21 (Feb. '24)	137	14 (Feb. '24)

Findings and Discussion

Developing *new* habits is quite different among the two instructional level groups. The main features presented by the sample investigated are the following. In lower grades of education, teachers disclosed the need to change their disposition to teach physics content, being aware they are able to teach them (skill) and knowing how to manage content in their level grade (knowledge).

High school Physics teachers have been enrolled differently in the process of changing habits [1, 4, 10]. They face many external constraints in activating their process (as school policy and textbooks based on traditional teaching methods). Thus, they first changed their disposition to engage students in a learning sequence that is basically different from "common-regular" lecturing. In order to do that, they underlined how important it is to know *new* tasks of teaching [4, 10, 11] to learn *new* management of content knowledge for physics teaching, which requires them to be skilled in scientific abilities that are sometimes never activated in their professional training process. These are first steps towards implementing a coherent ISLE-based curriculum [8].

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