

## Teaching4Learning@UniPD: The experience of the Department of Physics and Astronomy

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**Summary.** — Teaching4Learning (T4L) is a project of the University of Padua (UniPD) aimed at improving the quality of teaching in Higher Education by sustaining faculty professional development. The project features a series of residential courses for faculty, with the goal of building a “Faculty Learning Community” in each department that shares experiences and good practices, and takes a reflective, research-based approach to teaching. The Department of Physics and Astronomy joined the project in 2019 with the participation of 20 physics instructors in the first-level T4L course. In this contribution we describe the experience and its outputs, and we share some reflections and an outlook.

### 1. – Introduction

In recent years, several EU documents have highlighted the need for a more interactive and learner-centered teaching culture in Higher Education (HE) [1-3]. This renewed approach is robustly supported by research [4-7], even in the context of physics education, where research-based instruction and active-learning strategies have been shown to lead to an increase in students’ attendance, higher levels of student engagement, and enhanced learning [8-13].

Despite this large body of evidence, the actual adoption of educational innovations in HE is still limited [14]. In the Italian context, a nationally funded study called *Employability and Competences* [15] indicated that lecturing is still the dominant instructional format in universities; practices such as informal/formal feedback, peer and self-evaluation, teacher-student interactions, and collaborative activities are underrepresented; and many instructors are not aware of active, learner-centered teaching approaches [16].

However, a lack of faculty awareness of educational research results is not the only reason for the limited application of reformed instructional approaches. Research by Henderson and Dancy [17] suggested that the implementation of innovative teaching strategies depends not only on individual characteristics (instructor’s beliefs, values, and knowledge) but also on situational factors such as availability of resources (including

human resources), institutional expectations, and time bounds. In the light of these results, the authors concluded that dissemination of research results should be just one of four “core strategies” for innovation in HE: Disseminating Curriculum and Pedagogy, Developing Reflective Teachers, Developing Policy, Developing a Shared Vision [18-20].

These results highlight another limitation of typical faculty professional development: most interventions are focused on individual faculty innovators, whereas research shows that individual efforts without an attention to the wider context are unlikely to produce a systemic, institution-wide cultural change [21-24]. The challenges for authentic innovation in HE therefore include not only fostering the commitment of individual instructors, but also managing the relationship between the individual and the organization [25]. In the context of physics education, a successful example of this approach was the *Carl Wieman Science Education Initiative* [26]: its action at the departmental level together with the re-thinking of individual courses has provided structure to innovation [27] and has favoured the retention of the introduced changes [28].

A model of professional development that has proven to be particularly effective in promoting organizational change is the Community of Practice (CoP) [29]. A CoP is a group of professionals who care about a particular domain of knowledge and the shared practice they are developing to be effective in that domain [30]. In the context of HE, CoPs have taken the form of Faculty Learning Communities (FLCs), *i.e.*, groups of faculty members who meet regularly over a sustained period of time to reflect on how to innovate the teaching of their subject by engaging in active, collaborative and reflective practices [31]. The effectiveness of FLCs in fostering pedagogical change and addressing the learning needs of students is sustained by a growing body of research [23,31-33].

In the context of STEM subjects, FLCs have been identified as one of the “change strategies” for increasing the use of evidence-based teaching in HE [34]. Several successful examples have been reported in the literature. For example, O’Meara [35] examined the outcomes of a FLC composed by science, engineering, and mathematics faculty and reported improved self-efficacy and higher levels of confidence in teaching as a result of participating in the FLC. Elliott *et al.* [36] have transformed a large enrolment introductory biology course at the university of Iowa to include active learning with the support of a FLC in which instructors developed new pedagogies, adapted active-learning strategies to large courses, discussed challenges and progress, critiqued and revised classroom interventions, and shared materials. Tinnell *et al.* [37] reported how an engineering faculty was successful in implementing teaching innovation by engaging in an FLC and investigated the endurance of the introduced changes: their results suggested that many of the participants had retained much of the new pedagogical approaches into their ongoing practices, encouraged by evidence of benefits for student learning. Finally, Tomkin *et al.* [38] reported that participating in a FLC around instructional reforms has led to the adoption of active learning practices more easily as compared to faculty who are not members of a community of practice. They also reported that the positive effects of student-centered practices in terms of attendance and active participation were stronger for courses taught by instructors who were members of a FLC.

## 2. – Teaching4Learning@UniPD

Since 2016, the University of Padua (UniPD) has promoted an initiative, named Teaching4Learning (T4L), aimed at fostering innovative teaching in response to the needs and recommendations described above [39,40]. The goals of the project are: to encourage faculty to experiment and discover new teaching strategies; to promote students’ active

participation in educational activities; to de-privatize teaching; and to build FLCs in each department by building relationships among colleagues who share a research approach towards teaching. The programme includes four main courses: T4L, T4L-Level2, T4L-ChangeAgent (for those who have completed the first two courses and take the commitment to actively promote change in their departments), and T4L-NewFaculty. At the same time, initiatives at University level are pursued in order to set the innovation of teaching practices as a priority and to support other departmental actions that go in the same direction.

To date, 450 faculty have participated in the T4L programme. The large majority expressed satisfaction for the programme and found it impactful [41]. Since the effectiveness of the model begun to be supported by evidence, there has been a relevant financial commitment from the University, which has encouraged the participation of new departments and has supported further initiatives. Thanks to these actions, department heads have now become more sensitive to the importance of improving the quality of teaching, which contributes to a favourable context for continuing and deepening the reflection on didactic innovation. It is agreed that a systemic action at the organizational level is needed to facilitate the implementation and retention of innovative practices [42].

### 3. – The experience of the Department of Physics and Astronomy

The Department of Physics and Astronomy (DFA) of UniPD joined the T4L programme in 2019. The initiative fit into the context of the actions promoted by the Group of Research in Astronomy and Physics Education (GRAPE) aimed at improving the teaching and learning of physics in universities using a learner-centred approach. Whereas the previous actions were mainly focussed on the students [43-45], we recognized that we should start acting on faculty members as well. Although we believe that a real improvement of the teaching and learning of physics in universities cannot be separated from the results of physics education research, we viewed the T4L programme as a “first seed” for setting up a group of motivated colleagues who reflect on their teaching, and to fit our efforts into a systemic action at our institution. The proposed approach based on FLCs also resonates with our model of professional development; in fact, in the past two years we have experimented the CoP model in the context of K-12 education with positive results (project COLLABORA, <https://pls.scienze.unipd.it/fisica/formazione-insegnanti/>).

The programme included a “kick-off meeting” held at the department plus a residential week-end course in a setting located in the countryside close to Padua (Monteortone di Abano Terme) and it featured 30 contact hours in total. The residential nature of the course and the relaxing setting far from the department fostered an upgrade of the participants’ interactions, allowed a deeper sharing of ideas, and fostered socialisation. In fact, besides the training activities, social moments were organized in order to strengthen the relationships among participants and to promote their well-being during the workshop. We particularly valued these aspects since we are aware that learning is better sustained when it involves the affective dimension beside the cognitive dimension.

The participants were 20 self-selected faculty members including two full professors, nine associate professors, three faculty researchers (RU or RTDb), four fixed-term researchers (RTDa), one contract professor and one post-doc. The course lecturers were experts in adult education (Edward W. Taylor, Penn State University, USA, and Monica Fedeli, co-coordinator of the T4L project and advisor for didactic innovation and e-learning at UniPD) or in active learning strategies (Jon Wright, Studies of the Lan-

guage Project, Bristol, UK; Concetta Tino, UniPD, and Carlo Mariconda, full professor of mathematics, co-coordinator of the T4L project and advisor for higher education development, e-learning and distance learning at UniPD). The workshops were led with an active, learner-centered approach, involving both small-group and large-group discussions, and the participants had the opportunity to share experience, practice and methods. A wide range of methods, tools, and pedagogical approaches were showcased in practice.

**3.1. Contents.** – The schedule and contents of the T4L program @DFA are reported in table I.

The course moved from the participants’ teaching and learning perspectives using the *Teaching Perspectives Inventory* (TPI), an instrument aimed at making the respondents aware of how they teach and why they teach the way they do. The TPI refers on a teaching model that considers five dimensions: teacher, learners, content, context, and the instructor’s beliefs and values. The questionnaire contained 45 items, which were used to define a teaching profile according to five main perspectives (transmission, apprenticeship, developmental, nurturing, social reform) [46]. The goal was to make instructors more reflective about their teaching and to help them consider all of the dimensions mentioned above. By sharing and comparing their results with their colleagues, instructors would become aware that different perspectives may exist and they started exchanging ideas about teaching and learning.

TABLE I. – *Schedule and contents of the T4L program @DFA.*

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Jan. 28th, 2019	Contents and activities: <ul style="list-style-type: none"> <li>• Initiating a Faculty Learning Community.</li> <li>• Sharing of personal goals for the workshop.</li> <li>• Understanding the influence of personal beliefs about teaching and learning.</li> <li>• Review and analysis of the Teaching Perspective Inventory (TPI).</li> </ul>
Feb. 7th, 2019	Contents and activities: <ul style="list-style-type: none"> <li>• Engaging students through active learning.</li> <li>• Classroom planning.</li> </ul>
Feb. 8th, 2019	Contents and activities: <ul style="list-style-type: none"> <li>• Interactive lecturing and small groups dynamics.</li> <li>• Teacher-students relationships.</li> <li>• Innovative use of technology in the classroom.</li> </ul>
Feb. 9th, 2019	Contents and activities: <ul style="list-style-type: none"> <li>• Micro-teaching session.</li> <li>• Goals for the upcoming semester.</li> </ul>

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The final activity of the workshop, the microteaching [47], is a key element of the T4L program. The task for each participant was to plan a short lesson (10 minutes) on a topic of their choice, trying to implement some of the ideas, methods, techniques and tools presented in the workshop, while the trainers were available for support and coaching. The lesson was then delivered to their peers, that provided feedback using a structured grid as a guide. The goal of this activity was to experiment the principles, tools and methods encountered in the workshop in a “safe” environment, according to the principles of critical friendship and de-privatisation of teaching [23, 48].

All the T4L courses are based on the scheme outlined above, but each departmental FLC can adapt the schedule and specific contents based on their needs to decide how to continue their work together. In fact, for a FLC to be effective it is important that it finds its own internal direction and character [49] and that it has the opportunity to self-direct its learning, according to the principle of autonomy for self-determination [50, 51]. In the case of the DFA, specific examples taken from the literature in Physics Education Research (PER) [9-13] were provided. Videos and other digital resources (*e.g.*, PhET simulations), readings, and the topics of group discussions were also chosen in order to target the DFA faculty group. Due to the heterogeneity of the participants in terms of their students and the context of their courses (*e.g.*, bachelor *vs.* master level; physics majors *vs.* other majors; small *vs.* large classrooms), no specific physics topics were selected; in some situations (*e.g.*, in small-group discussions), particular topics were chosen by the members of the subgroups according to their interests and the courses they taught. All the PER-related examples were focused on active learning and the student-centered approach, while no discussion of disciplinary issues was made as this was outside the scope of the workshop. A discussion about how disciplinary issues should be taken into account as the FLC is continued is contained in the final section of this paper.

**3.2. Participants’ satisfaction.** – The participants’ satisfaction was investigated with a questionnaire employing a 4-point Likert-type scale (1: strongly disagree; 4: strongly agree). A summary of the participants’ responses is provided in fig. 1.

Overall, the participants were very satisfied with the programme (3.7/4 on average), found it useful (3.5/4) and would recommend it to other colleagues (4.0/4). After attending the programme, the participants felt more confident to innovate their approach to teaching (3.4/4): “Now I consider that change is possible and can be useful” (Faculty 3).

Among the proposed methods, the participants stated they would most likely try to use small-group discussions (3.6/4) and interactive lecturing methods and techniques (3.5/4) as a result of the programme. In fact, according to the participants’ account, “it is important to improve the quality of lectures through a continuous connection and dialogue with the students (...) this is useful to maintain their attention, to let the students be involved and to facilitate their learning” (Faculty 14). Moreover, most participants stated they would try to be more innovative concerning assessment, feedback and evaluation (3.4), to take advantage of the role of emotions and feelings in the learning process (3.4/4), to work at fostering positive student relationships (3.1/4), and, in general, to adopt a more student-centred approach: “The most important thing I learned is to target the need of students to become independent as learners” (Faculty 13).

Finally, most participants would like to be part of a Faculty Learning Community to share teaching experiences with their colleagues (3.4/4) and would like a colleague to conduct a peer observation of their teaching (3.6/4).

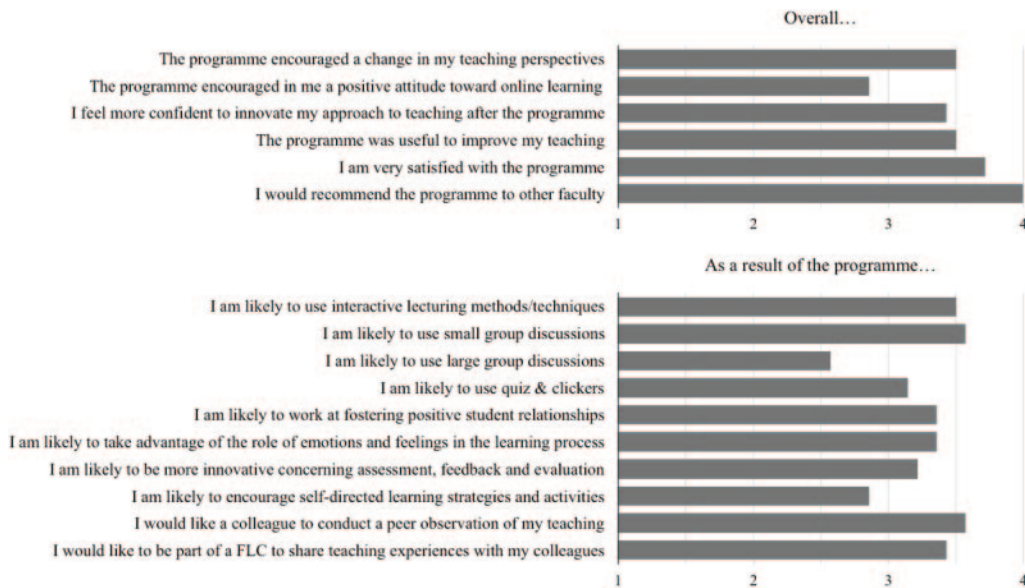


Fig. 1. – Final questionnaire results (average). 1: Strongly disagree. 4: Strongly agree.

**3.3. A short case study.** – We report the experience of one of the 20 faculty members that took part in the T4L course at DFA, which we will call “Faculty A” for convenience. Faculty A is an associate professor teaching general physics in the first year of one of the degree courses of the School of Science at UniPD. Before the T4L course, Faculty A had never taken part in a workshop about teaching, even though he had participated to a couple of courses about team building and communication organized by the Italian National Research Council (CNR). “The T4L course arrived just at the right time. I was having a very intense period at work and I needed something to inspire and motivate me”, he says. “We should repeat such an experience every year, like a “booster shot””. Faculty A’s course started right after the workshop: “After the programme, I changed many small things in my didactic action. Now I keep a different attitude toward the students, more interactive and friendly; I use technology (especially videos) in a more thoughtful way; and in general, I propose more small-group activities to promote active participation of all”.

Our colleague reports evidence of positive effects of the introduced changes in terms of students’ participation, satisfaction and performance, in line with previous research accounts [10]. Concerning participation, he observed a smaller drop in students’ attendance to the lectures compared with the previous year. In fact, out of the 40 students that were present on the first lecture each year, 35 (on average) were consistently present during the following lectures in the course, compared to an average of 25 students coming to the lectures in the previous year. The students’ satisfaction was evaluated by analysing end-of-course students’ questionnaires: the students’ opinion on the course was very positive and the newly introduced techniques were mentioned frequently and judged useful. Finally, in order to evaluate the effects on the students’ performance, Faculty A evaluated the students’ gain in the mid-term exam with respect to the entrance test, and

compared it to the previous academic year. He observed a clearer improvement of the students' performance after the introduction of the new techniques. Though he is aware that more data would be needed to ascertain the source of this improvement, Faculty A believes that "part of the merit is due to the new techniques and ideas I learnt in the T4L programme".

For the moment being, the changes reported by Faculty A seem to be mainly at the individual level; in fact, he reports that his interactions with colleagues concerning teaching did not really change, even though he disseminated his knowledge to a colleague who did not take part in the workshop "and I know he did try". Faculty A acknowledges that more work should be done in order to effectively sustain an authentic faculty learning community: "As I said before, we should do it again and again. Most of all, I liked the format; it promoted team-building, which is often missing in our context. Any proposal for further faculty development should not neglect this aspect".

#### 4. – Lessons learned and outlook

The T4L experience at the Department of Physics and Astronomy was in general very positive according to the colleagues who took part in the programme. The course has activated a reflection on teaching and has elicited a need for improvement. However, the impact was mostly on small, individual changes such as adopting some new techniques and observing their implications, while the impact at the departmental level seems to be still limited. This was reported also by previous accounts [41].

"Starting small" is often the first step for change, since successful practice has been listed as the primary source of self-efficacy [52] and can motivate people to promote innovation. However, a bottom-up approach is unlikely to be effective without top-down actions at the organisational level. A first effort in this respect has been proposed by one of the participants, who is also the director of the PhD school in Physics at our Department. He proposed a course for PhD students based on the T4L format, but designed in collaboration with our research group in order to entail a specific focus on physics education. The course will be organized in 2020. Moreover, a new faculty professional development project has been funded at our department and will be organized by our group. This course will also contain a focus on physics education. These projects look promising in sustaining the development of a departmental culture that values the quality of teaching, and would not have been possible without the T4L experience.

Among those who are aware of the complexity and richness of research in physics education, the usefulness of a course on general didactic issues may be questioned. In fact, the core of our research field is the awareness that a specific reflection on disciplinary issues, brought about by discipline experts, is needed to increase the quality and the effectiveness of physics teaching, and that the effectiveness of any technique or method cannot be assessed without making reference to the specific learning outcomes of the discipline. We agree on this point, but we are also aware that our colleagues have never had any pedagogical training, nor the importance of reflecting on their own teaching has been brought to their attention by the system before; most of them have never had the opportunity to stop and reflect on their practice, and even less have ever considered teaching as a field of research. For this reason, we find it useful to create opportunities for building a common language, for meeting and talking to each other, for raising the attention on the problem, and ultimately for eliciting the need and the wish for further professional development. We believe that this approach can contribute to a favourable ground for change, and that it is important to act in synergy in order

to reinforce the idea that a cultural change is needed, urgent, and shared by all the stakeholders.

In conclusion, we view this programme as a good opportunity for starting a faculty learning community by setting up of a group of colleagues who are sensitive to the issues related to learning and teaching. We believe that this, in turn, could create the basis for effectively delving into the disciplinary issues and recognising the role and the value of physics education research at both the individual and the departmental level.

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