Regular Article

From teacher to teacher-trainer: A qualitative study exploring factors contributing to a successful train-the-trainer digital education program

Emilie-Charlotte Monnier [*], Sunny Avry, Laila El-Hamamsy, Caroline Pulfrey, Christiane Caneva, Francesco Mondada, Jessica Dehler Zufferey

École Polytechnique Fédérale de Lausanne, Center for Learning Sciences, EPFL AVP-E LEARN, ME B3 464, Station 9, 1015, Lausanne, Switzerland

ABSTRACT

This paper explores the experience of 14 teacher-trainers involved in a train-the-trainer digital education program in Switzerland. Data collected between August 2019 and June 2021 through focus groups and collaborative portfolios were analyzed through thematic analysis. A qualitative analysis was used to identify the main factors facilitating or hindering their experiences. These facilitators and obstacles were related to individual characteristics, interactions with stakeholders, instructional content, and logistics. Based on these findings, recommendations are provided to help training designers to maximize the success of such initiatives.

1. Introduction

On average in the OECD countries, fewer than half of teachers (49.1%) report that information and communication technology (ICT) was included in their formal education or training (European Commission, 2020). Teacher professional development (TPD) is a crucial component of digital reforms in education worldwide (Moulakdi & Bouchamma, 2020). By providing teachers with the support they need to change their classroom practices, attitudes, and beliefs, TPD can help improve student outcomes (Guskey, 2002). Indeed, training educators should be an essential concern as trained and committed educators are a key element of successful implementation programs (Fixsen, Naoom, Blase, Friedman, & Wallace, 2005; McGuire, 2001).

Digital education[1] (DE) implementation, as a new discipline, must benefit from efficient TPD support to guide teachers in this delicate process (Donnelly, McGarr, & O'Reilly, 2011; Wang, Hsu, Reeves, & Coster, 2014; Guggemos & Seufert, 2021). In large-scale reforms, having enough experts to disseminate quality TPD is a challenge that often cannot be met. A "train-the-trainer" (TTT) strategy (Orfaly et al., 2005) - where trainers are selected and trained because of their ties to the community targeted for training - can be a solution to that professional development challenge. When adopting a TTT strategy, the chosen teachers must develop a new posture to go from teachers to teacher-trainers (TTs). Not only do they have to stay close to their peers, but they also need to embrace a new legitimacy as trainers (Cros, 1997). Given that educational reforms should be efficient and sustainable (Coburn, 2003), knowledge of the factors facilitating or hindering a TTT strategy can improve the implementation of quality DE reforms.

2. Theoretical framework

2.1. The train-the-trainer strategy

Coupled with access to technical assistance and coaching, teacher training has proved necessary for quality reform implementation (Ray, Wilson, Wandersman, Meyers, & Katz, 2012). As the integration of DE is a complex process, active involvement of different stakeholders (curriculum experts, education managers, teacher-trainers etc.) is all the more necessary to generate meaningful and sustainable change in teaching practice (Berger & Thomas, 2011), one of the biggest challenges in education (Hubers, 2020). An effective strategy to increase trainers' knowledge and skills is the TTT model (Poitras et al., 2021). Often used in the health sector, this model enables potential trainers to acquire the abilities to share what they have learned with other members of their community (Ray et al., 2012). When applied to the context of education, the model can be particularly useful because of the variety of teaching practices, the need to adapt to each group of teachers' needs,

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Abbreviations	
DE	Digital education
TPD	Teacher professional development
TTT	Train-the-trainer strategy
TT	Teacher-trainer
FG	Focus group

the need to integrate new teachers into a new educational culture, and the rapidly changing educational standards and norms (Demarle-Meusel, Rottenhofer, Albaner, & Sabitzer, 2020). Several studies have found that this procedure is highly successful and economical (Hayes, 2000) but suffers from drawbacks. To help guide the conception of TTT initiatives, Mormina and Pinder (2018) developed a conceptual framework consisting of five sustainability factors *(Talent, Resources, Alignment, Implementation, Nurture and Development, TRAIN)* based on an in-depth examination of 15 completed health initiatives TTT programs. Snowden and his colleagues (2022) added the *Context* factor after a recent systematic review. In the next paragraphs we explicit the sustainability factors behind Mormina and Pinder's framework (2018) (completed by the context factor of Snowden, Lahiri, Dutton, & Morton, 2022) using the process model of Lane and Mitchell (2013) to temporally structure the explanation (see Fig. 1). We also address the main drawbacks highlighted by various studies.

(1) *The champions identification*

The *talent factor* in the conceptual framework of Mormina and Pinder (2018) first consists in the selection by a group of experts of teachers with the desired characteristics. Trainer with a) motivation, self-efficacy and legitimacy feeling to engage in the professional development of their own colleagues (Engelbrecht & Ankiewicz, 2016, Dichaba, 2012), b) technical and training skills (Snowden et al., 2022), c) interpersonal skills (honesty, patience, listening, credibility, etc.) (Kandiller & Özler, 2015), d) organizational skills (Chatziefstathiou & Phillips, 2011) and d) content and pedagogical knowledge (Ngeze, Khwaja, & Iyer, 2018) must be selected and retained. To the best of our knowledge, no research has been done around the competencies needed by teachers becoming trainers in DE. Therefore, no references to technological knowledge are made except for Kandiller and Özler (2015) who mention TPACK by Mishra and Koehler (2006).

Second, the framework states that a TTT initiative will succeed if integrated with individual professional goals *(alignment factor)*. Indeed, to prevent attrition, being a trainer should be seen as a career path rather than an extra task. At the organizational level, this career path should be aligned with policies and process (Snowden et al., 2022) This factor is also linked to the need of trainee-perceived credibility identified by Bax (2002).

Third, the elements *(resource factor)* that support the initiative such as time, materials, supplies, personnel and structures must be in place. This factor is also a limitation reported by other literature. Orfaly et al. (2005) identified the difficulty new TTs may have in organizing and following through the training program because they lack time to co-ordinate and plan the training process without the expert trainer support and resources.

(2) The champions development

The second phase is where the future TTs start receiving a specific training from the group of experts. The *implementation factor* is reported by the systemic review of Snowden et al. (2022) as the most impactful factor to achieve and sustain change and represents the delivering of a solid TTT training that transfers ownership of the program (Coburn, 2003) and sustains the cascade effect. This ownership process must be carefully monitored to avoid instructional content dilution (Demarle-Meusel et al., 2020; Hayes, 2000), curriculum misunderstanding (Suzuki, 2011) and adaptations that should not be made (Van Daele, Van Audenhove, Hermans, Van den Bergh, & Van den Broucke, 2014).

(3) The champions integration

The process ends with this third phase where the TTs train teachers while the experts endorse an evaluating and supporting role. Indeed, conducting training under the supervision of an expert is a key success for TTT initiative (Mormina & Pinder, 2018). In fact, if the initial transfer of knowledge (hard and soft skills) is very important, preventing deskilling overtime is crucial for sustainability (Mormina & Pinder, 2018). The *nurture and development factor* involves opportunities of CPD that should include one-to-one peer-support, access to relevant literature, further courses and networking opportunities beyond the partnership. Other literature reported important limitations when not enough development is provided: lack of confidence (Engelbrecht & Ankiewicz, 2016), lack of expert trainers' support (Ngeze et al., 2018; Robinson, 2002) or lack of supervised training conducted by expert trainers (Baron, 2006). Ray et al. (2012), detail how TTT programs often underestimate the ability of the participant to master the required information and skills rapidly and recall it over time.

The *context factor* supports the whole process and is described as "the specific setting, culture, environment, economic/social/political dynamics, and needs that could affect capacity building TTT initiative success". Monitoring and evaluating is also included in this factor.
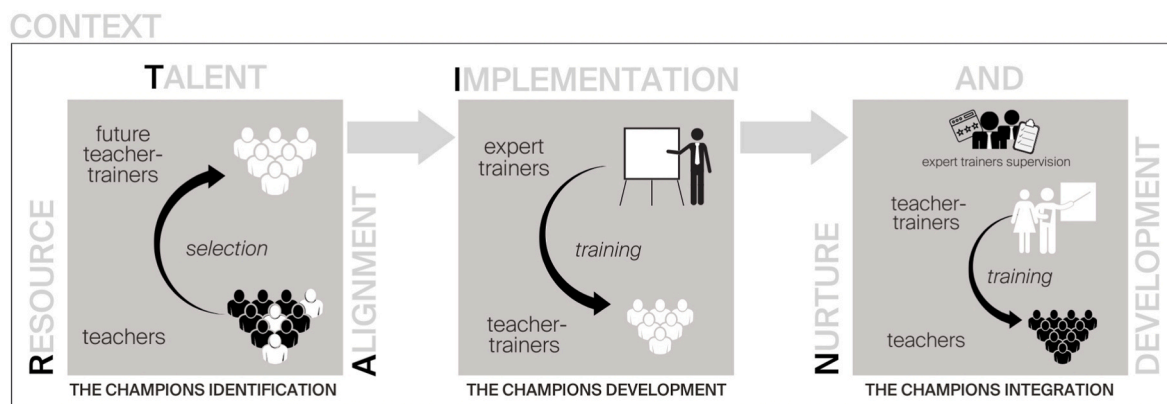

Fig. 1. Different TTT program phases with temporal steps (Lane & Mitchell, 2013) and sustainability factors (Mormina & Pinder, 2018; Snowden et al., 2022).

2.2. Digital education integration

While the obstacles described above do not specifically refer to a DE training, we believe they are relevant in this specific domain as they are additional challenges involved with integrating this new discipline into curricula worldwide (Stringer, Lee, Sturm, & Giacaman, 2022). A thorough search of the relevant literature yielded no study to date that has focused on evaluating a TTT model in a DE training project. Nevertheless, documented barriers in DE integration highlight the possible obstacles that TTs will need to take into consideration to promote better adoption. External barriers (obstacles extrinsic to teachers) are reportedly: lack of resources (e.g., access to equipment, network, instructional software, and educational digital resources, Schmitz, Antonietti, Cattaneo, Gonon, & Petko, 2022), lack of support (e.g., availability of technical support and opportunities for professional development mainly in the interaction between technology, content and pedagogy, Ertmer & Ottenbreit-Leftwich, 2010) and lack of institutional strategies (e.g., administrator's priority, school-wide vision, Spiteri & Chang Rundgren, 2020; Hew & Brush, 2007). Internal barriers (obstacles intrinsic to teachers) consist of knowledge, skills, and teacher beliefs (Xie, Nelson, Cheng, & Jiang, 2021). Guggemos and Seufert (2021) reported that lack self-efficacy may be more important than skills and knowledge among teachers who implement technology in their classrooms. Scherer and Teo (2019) considered teachers' attitudes and the beliefs that shape them as good predictor of their intention to use technology. Helping teachers overcome these aspects is constitute additional challenges faced by TTs and expert trainers in the specific context of DE reforms.

2.3. Rationale of the study and research question

The present study therefore intends to contribute to the literature on TTT initiatives by investigating a TTT program within a DE reform context. More specifically, we examine further the obstacles and facilitators of TTs' experience in learning and teaching by adopting a phenomenological point of view that can help understand the underlying reasons to every obstacle and facilitator and propose recommendations for better training design. Indeed, it has appeared to us that the existing literature has mainly explored these challenges from an external point of view with little consideration of the experience of the most affected stakeholder, the TT her/himself even though it is a key element of an effective and sustainable TTT program (Martinez Leal et al., 2022).

By investigating the experience of TTs in a specific DE program, we propose to solve the main concerns tackled by the literature (training content dilution and TTs attrition) by exploring the reality of TTs experience when continuous support of expert trainers and digital instructional coaches are in place. By demonstrating it in the context of DE which, being more complex, could therefore make it possible to validate its effectiveness and therefore potentially be generalizable to other contexts. Therefore, the following research question is considered: What are the factors reported by teacher-trainers that enhance or hinder their experience in a large-scale digital education reform?

3. Method

3.1. Study background

In this article, the experience of TTs in a large-scale DE reform in Switzerland is examined. The project aimed to integrating DE (Computer Science, Information and Communications Technology and Digital Citizenship) to all students in K-12. To that effect, teachers from 92 public schools participated in continuing education programs to integrate DE into their teaching practices. Twelve public schools participated in a pilot program initiated for primary school in 2018–2019. These are followed by 17 schools in the first deployment phase (2020–2023), 21 schools in the second deployment phase (2023–2025)

and 18 schools in the third deployment phase (2025–2027). The project's organization was a cascading process with many different stakeholders: Experts from one engineering and one teaching university who oversaw the content creation and training. The experts were content creators and trainers for the pilot phase which was essential to test and improve the program and materiel (see El-Hamamsy et al., 2021 for more detailed information about this phase). In-school instructional coaches were also hired to help with global daily digital coaching. Instructional coaches are regular teachers who are trained to support every day on-site professional development to their colleagues. They stay affiliated to their school, but their training was supported by the universities in charge of the content creation and training (to learn more about their role, see Caneva et al., 2023).

To prepare the deployment phase and disseminate the teacher professional development program to all primary school teachers (between 429 and 718 teachers at a time), a recruitment call for teachers was made to find 16 TTs that would be trained to train their peers of the first four levels of primary school (children from 4 to 8 years old). In total, 11 women and 5 men were selected among the teachers who applied. The selection was made based on the criteria highlighted by the literature (enthusiasm to train their peers and be part of the project, interest in digital education, current teaching experience, basic soft skills to teach to adults). Digital education competences were not a pre-requisite as the plan was to upskill TTs during the theorical sessions of the professional development program.

Regarding work organization, TTs worked one day per week as TT and the rest of the time as teachers, which remained their primary occupation. Although the TT training does not lead to a specific certification, it can be valued as a professional experience. TTs did not receive an added salary but had benefited from a proportional reduction in their school teaching hours. Fig. 2 describes the distinct levels of the training program and the different stakeholders involved in creating and implementing the TTT program.

After the pilot phase, where teachers were trained by expert trainers only, TTs' training program was designed to scale up in the deployment phase. The TTs' training was conceived by expert trainers according to digital competency standards covering 3 main areas: 1) teaching computer science, 2) teaching digital citizenship, 3) integrating digital technologies into teaching practices. A fourth element of coaching concerning the posture of the trainer was also added to the training plan.

At the beginning of the TTs training sessions, the experts paired them into 8 groups of 2 to act as pairs of trainers (tandems). This choice was made according to best practices which suggest that co-leadership can improve learning by providing better clarity of the subjects, better ability to handle conflict, better preparation and support (Cohen & DeLois, 2002). The TTs' training involved 29 days of theoretical training (provided by expert trainers) and 15 days of practical training (where each pair of TTs delivers the training to K-3 teachers) in the deployment schools. The training sessions[2] were given alternatively (as illustrated in Fig. 3 and described in Table 2). For example, TTs received 10 training sessions by experts then went to the schools to teach 10 training sessions and came back for 10 more theoretical sessions and so on.

3.2. Participants

The study's participants are the teachers that were hired to be TTs in the digital education curricular reform who agreed to take part in the study and stayed until the end of the study.[3] Table 1 describes their

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[2] Training sessions are of two kinds: 1. When TTs are trained by expert trainers (for exemple: teaching content, adult trainer skills, ect.) 2. When TTs trained their peers in the different deployment schools (4 training sessions per year for each teacher).

[3] Over 16 participants, 1 had to leave for health reason, and 1 didn't agree to participate in the study.
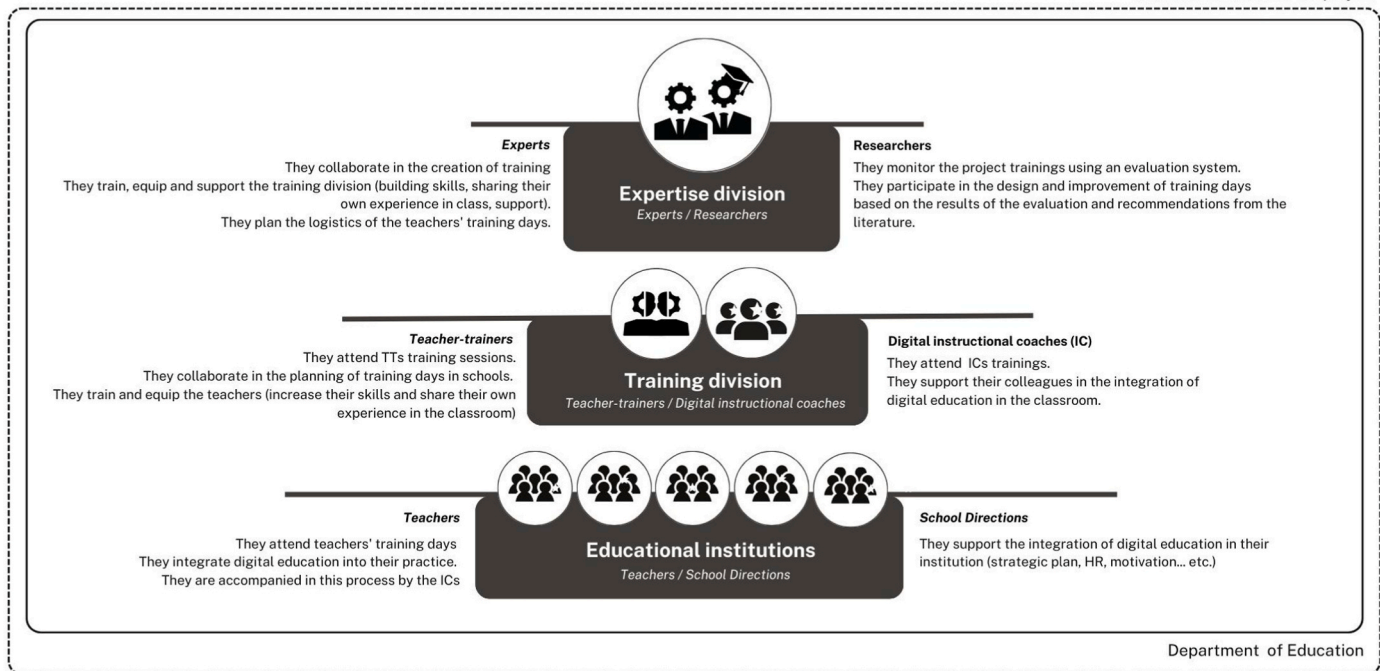
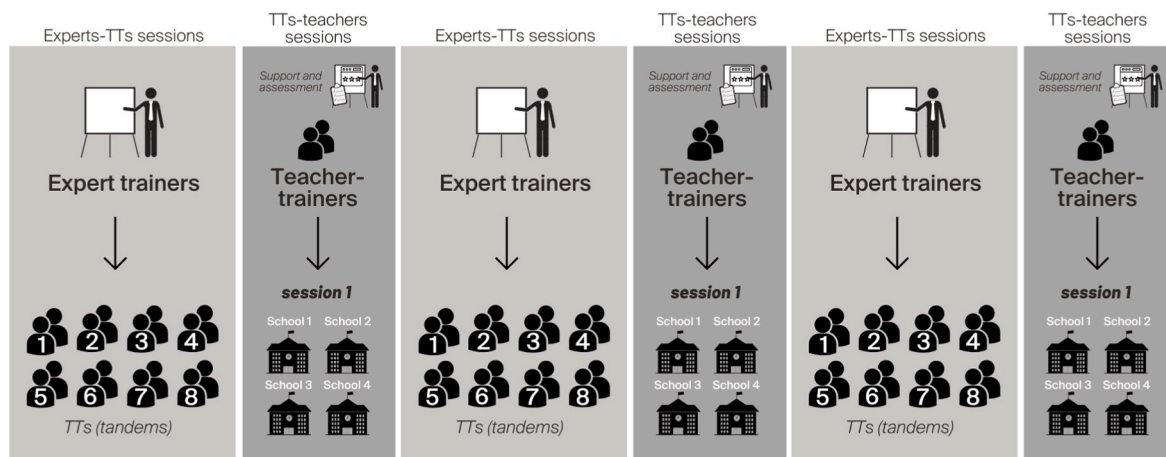**Fig. 2.** Organization of the digital education project TTT program.

Fig. 3. Organization of the TTT training sessions.

Table 1
Description of the sample.

Number of participants	14
Female (%)	71
Teaching experience (years, mean ± sd)	19.7 (9.2)
Digital instructional coach experience (%)	71
I**nitial training grade** (%)	
Cycle 1 (pupils age 4–8)	42
Cycle 2 (pupils age 8–12)	28
Cycle 3 (pupils age 12–16)	21
All cycles	7

characteristics. Ethical consent forms were signed by each participant, and they were aware that they could stop participating at any point in time.

3.3. Data collection and analysis

The data collection period took place over nearly two years between August 2019 and June 2021 (Table 2). Data were collected using focus groups (see section 3.3.1) and collaborative portfolios (see section 3.3.2). For a more precise description of the data collection (timeline and survey questions), see Appendix A.

3.3.1. Focus groups data collection

Four focus groups were organized with the 14 TTs to enhance group interactions (Ho, 2006). Furthermore, as the TTs know and trust each other, more free speech is expected (Kitzinger, 1994). To get a maximum of six to eight participants per group (Krueger & Casey, 2000), two researchers were involved in the focus group sessions. However, one FG was led with the whole group because of organizational constraints. Each FG lasted between 45 and 75 min.

The questions asked during the FGs were chosen according to the

Table 2
Timeline of the project with training sessions description and data collection.

Date	Training sessions	Data collection
August 20 to March 21	Teacher-trainers' training session A	*Portfolios* *August:* Focus group 1 *March:* Focus group 2
March 21 to April 21	Teachers' training session 1	*Portfolios* Focus group 3
Mai 21 to June 21	Teacher-trainers' training: session B	*Portfolios*
September 21	Teachers' training session 2	
October 21	Teacher-trainers' training session C	
November 21	Teachers' training session 3	
December 21 to February 22	Teacher-trainers' training session D	Focus group 4
March 22	Teachers' training session 4	
Avril 22 to June 22	Teacher-trainers' training session E	Participant validation

project timeline. The first FG occurred after session A of the TTs training. At this time, the TTs had not yet given any trainings themselves and questions about the collaborative portfolios, their content and their use were discussed. The second FG occurred after session 1 of trainings in the schools. The questions were intentionally designed to explore personal experience related by the group, rather than driven by theory (Massey, 2011). In the third FG, which took place right after the first round of the 14 in-school training sessions, the emergent themes of the first FG were questioned again and TTs were encouraged to discuss changes or adaptation related to these themes. In the fourth and last FGs, the questions about TTs' obstacles were theory driven. The TRAIN framework led the question asked about the TTs experience (e.g., risk of TTs attrition, risk of content dilution, need for multiple competencies, need for high motivation). See Appendix A for more detailed information.

3.3.2. Collaborative portfolio data collection

The collaborative portfolio project was designed to provide access to the TTs experience on a weekly basis. There were several goals for the portfolio assignment that was determined by the expert trainers: (1) to emphasize the reflexivity of the TT, (2) to develop digital skills and familiarity with the working tool (tablet), and (3) to allow collaborative exchanges between expert trainers and TTs. To encourage users to express themselves freely in their portfolio, the CPs were only shared with expert trainers. The use of this reflexive tool was strongly encouraged, and feedback was provided every week by the expert trainers. To support the creative process and encourage meaningful reflections, a canvas was provided to TTs. They were free to complete the CPs when and how often they wanted, with the only constraint being to use a specific creation software (the word processor Pages) to take advantage of its collaborative features and commenting functions.

3.3.3. Focus group and portfolio analysis

The focus groups and portfolios were analyzed using a thematic analysis (Braun & Clarke, 2006). This method has the advantage of being flexible and avoiding the constraints of a strict theoretical framework. A socio-constructivist approach was chosen given its consistency with the TTs experience who constructed and interpreted their own realities by interpreting what was available to them (Taylor & Ussher, 2001). Indeed, the purpose of this study was to observe a phenomenological process, i.e., an individual and personal perception of an event (Smith, Jarman, & Osborn, 1999) rather than an objective statement of this event.

The data was first transcribed and organized in the qualitative data software NVivo12. The focus groups and portfolios were first read by two coders to familiarize themselves with the data (Braun & Clarke,

2006). In order to ensure reliability between them (Syed & Nelson, 2015), an iterative codebook was first developed using a theoretically driven inductive approach. According to Syed and Nelson (2015, p. 7), this analysis generates the coding system inductively (main characteristics of TTT training in term of advantages/disadvantages) and allow coders to identify and name the codes. A codebook was then provided to the coders involved with a data sample to practice on. The codebook included a description of the codes with positive (what is meant by it) and negative (what is not included by it) examples when necessary. The *"reconcile difference via consensus"* method (Syed & Nelson, 2015) was then used on the full transcripts. This approach involved having two coders code all the data and then discuss the discrepancies found to reach a consensus. At the end of this process 66 codes were identified and a 99.7 percent agreement was reached with a kappa coefficient of 0.86 which is excellent according to the guidelines suggested by Bakeman and Gottman (1997).

Then the 66 codes were collated into potential themes. As suggested by Braun and Clarke (2006) a visual representation of the different codes was used to start combining them. The proposed *candidate* themes were then reviewed. Internal homogeneity (Are the data in the themes coherent together?) and external heterogeneity (Are the themes identifiable separately?) were the two criteria (Patton, 1990) that guided the decision to combine, discard or specify candidate themes. A provisory thematic map was then created and the data was read again to check whether it reflected the entire data set and whether additional data was missed in the previous steps. The selected themes, now called factors, were then defined and named considering how they related to each other (Braun & Clarke, 2006) and how they reflected the same factor either seen as an obstacle or a facilitator or both by the TTs. The full list of the 19 factors and examples of related quotes are available in Appendix B.

In the last part of the analysis, the final coded factors were presented to the group of TTs in order to validate the relevance of the thematic analysis. The validation included questions about the importance of the themes uncovered in terms of advantages or disadvantages through 7-point Likert scales. An example question is as follows *"From the various focus groups and logbooks, we have identified the following factors that have had an impact on your experience of TT. How much do you think they reflect what you have personally experienced?"* This phase, known as "member checking" or "participant validation", was used to explore whether results resonate with the participants' experience (Birt, Scott, Cavers, Campbell, & Walter, 2016). Secondly, it provided more reliable measures of importance, given that the raw references scores from the coding phase did not reflect the true importance of the themes among the participants (e.g. by reflecting the point of view of more dominant members in the focus groups).

4. Results

The thematic analysis led to the identification of 19 factors that were more seen as facilitators or obstacles depending on the situation or the viewpoint of the participant. These factors and the way the TTs felt about them are described in the following sections and are sorted in three groups:

4.1 The TTs talking about the training sessions for TTs
4.2 The TTs talking about the training sessions for teachers by TTs
4.3 The TTs talking about the interactions with the different stakeholders.

The reference frequency (number of times a factor was cited in the specific group) is mentioned for each of them. Pseudonyms are used in reporting quotes.

4.1. The TTs talking about the training sessions for TTs

The factors related to the TTs' sessions were either about personal characteristics or about training characteristics. Both categories included obstacles and facilitators (Fig. 4).

4.1.1. Personal characteristics

The TTs considered their motivation to be more a facilitator *(58)* rather than a barrier *(18)*. Many factors were drivers of their motivation such as the status of the universities involved in the training, the need to diversify their activities, their interest in adult training or the skills they already had in digital education. However, as time passed, the need for recognition (e.g. through financial benefits or a diploma) began to emerge. Indeed, their new role is neither valued with financial compensation nor certificated with a diploma. This has increasingly become a real obstacle for the TTs: *"Sometimes when I'm tired of spending hours preparing the training, I tell myself that to be paid the same amount, I'd better stop and just become a normal teacher again"* (anonymous survey comment).

The TTs were more nuanced when they talked about their perceived self-efficacy, seen both as a facilitator *(53, e.g., "I feel well prepared, very well prepared", Sacha)* and a barrier *(35, e.g. "How am I going to give these training sessions when I don't know everything myself?", Erika)*. This last quote refers to one of the many references made about the TTs not feeling they have as much expertise as the expert trainers.

The same ambivalence was found with their feeling of legitimacy. While it appears that they feel quite legitimate to train their peers especially because of their current teaching experience *(27, e.g. "We are not outside their reality. We are like them.", Sacha)*, they also question the legitimacy received by the experts, school and state manager *(31, e.g. "Perhaps we are taken less seriously by the school management than those coming from [the two universities involved in the project].", Lara)*.

Having less adult trainer and content skills than the experts was also clearly considered as an obstacle *(42, e.g. "We face children most of the time not adults and we don't talk the same way with them. I find that we are still not trained enough for that.", Thérèse)*. Moreover, the TTs who already had an experience in digital instructional coaching considered themselves better equipped and legitimate than their peers *(38, "The digital instructional coach training allows me to be more prepared and to better understand the whole project", Estelle)*.

4.1.2. Characteristics of the TT's training

The TTs appeared satisfied by the quality of the training program they received and saw it as a facilitator *(30)* as they were able to rely on what they learned. On the other hand, they were also aware of its complexity given the large number of concepts they had to master before the first teachers' training session *(34, e.g., "There are so many resources that I don't know where to start. I would like to read everything, but it's so much that I get discouraged after a few hours.", Erika)*. The amount of time they had between their first TT training session and the first day of training in the schools was also regularly mentioned. Thanks to Covid, the TTs had several additional months to appropriate the content and

they recognized this time as an important facilitator *(60, "I realized that there was still a lot of work to do between what was presented to me during our training, the appropriation of the content and the moment when I will transmit the training to the teachers.", Remi)*. During this appropriation time, the importance of training overview is also mentioned: *"We know that if we remove something, it doesn't matter because we have had time to become aware of the overall nature of the training: what we should lead them to at the end." (Juliette)*.

4.2. The TTs talking about the training sessions for teachers by TTs

The factors related to the teachers' sessions can be linked to different characteristics such as technical, teaching and organizational characteristics. Obstacles and facilitators were found for each one of them (Fig. 5).

4.2.1. Technical characteristics

Technical problems occurring during the sessions *(67)* and lack of school infrastructure *(44)* are the two most frequently mentioned obstacles. However, adequate equipment (such as a portable video projector, screen, hotspot and personal smartphone connections), technical assistance (such as a hotline and specific IT support, *11*) and efficient school infrastructure *(17)* appeared helpful to resolve some of the problems encountered: *"Connection to the platform is impossible for some teachers: We had to call the hotline during the training" (Anna)*.

4.2.2. Organizational characteristics

The stability of the tandems was eagerly discussed and was either seen as a positive outcome *(22, e.g. "There is great added value in always having the same training partner. If we changed partners all the time, we would lose a lot in training quality", Margaux)*, or a missed opportunity *(4, e.g., "Changing partners is disturbing because it forces you to adapt, to review your speech, your presentation slides but at the same time it is beneficial", Estelle)*. If stability inside the tandems was questioned, the debate also addressed the advantage/disadvantage of having tandems follow the same group of teachers for all the teachers' training sessions. One TT tandem reported that it was better because it helped them build a relationship with the participants (e.g., *"We know the teachers. They know us. We eat lunch with them. It is important to follow them through the training days", Simeon)*. However, others considered it problematic if TTs and trainees were not getting along. Adaptation to the context were also often perceived as an important factor that can enhance *(28)* the training but mostly one that can hinder it *(39)*. Time management is the most given explication: *"The time must be adapted to each group. It completely changes every time. The fact that we were given a timing is difficult to manage (Christiane)*.

Fig. 4. *Number of thematic references about obstacles and facilitators made by the TTs when talking about* the training sessions for teacher-trainers.

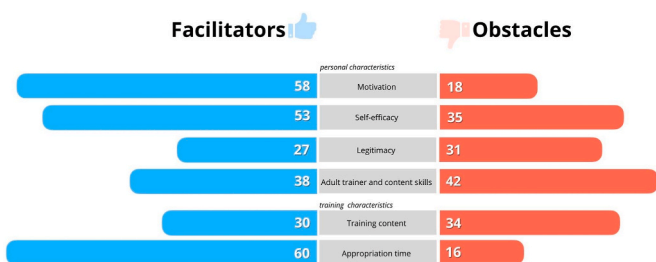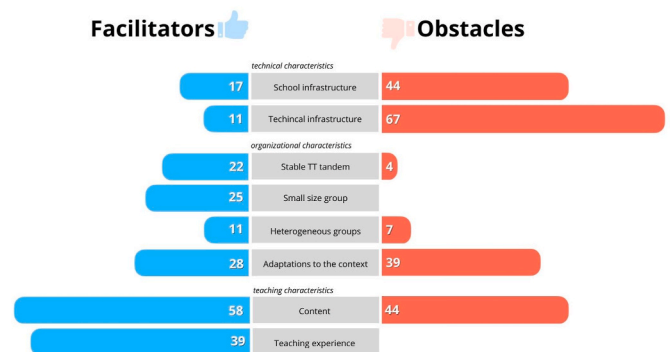**Fig. 5.** Number of thematic references about obstacles and facilitators made by the TTs when talking about the training sessions for teachers by teacher-trainers.

4.2.3. Teaching characteristics

The training content is a very important topic for the TTs *(58 references as facilitators and 44 as obstacles)*. When asked about loss of content, the TTs did not think that the cascading process (handover between experts and TTs) led to content dilution. On the contrary, they thought that, as the sessions passed, they improved the training program by becoming more at ease with the content and by making links between the different training subjects. They also perceived the possibility of adaptation and adequate time management as important facilitators: *"I don't completely eliminate parts of the training because if they're there, they were designed to be there. But I find it important to add a little bit of my touch" (Simeon)*. Training content complexity is often referred to *(44, e.g. "They [the teachers] tell us: I don't feel like I've been trained, I feel like I've seen an entire catalog. But they need to have a grip on their learning and they need to take it slow", Emmanuelle)*. Besides, the TTs found it hard to adapt some activities to specialist teachers (music or crafts teachers), as the content was mainly related to Digital Education. This was particularly the case when the activities are not easily useable in their classroom: *"It is said that one of the advantages of the project is to re*ceive ready-to-use teaching packages. *But these specialists, they don't get anything. They must create and imagine everything" (Thérèse)*.

Of course, small *(25)* and heterogenous *(11)* groups are considered as facilitating conditions because of the possibility to help everyone and to learn from one another: *"There is a natural connection in small groups. When you come and sit next to a few unmotivated, not interested in technology people and say: "now we're are doing it together". Nobody says no." (Jacques)*.

4.3. The TTs talking about the interactions with the different stakeholders

The factors related to the different interactions between stakeholders can be sorted for each level of the TTT model: the teachers' level (teachers and school management), the TTs' level and the experts' level. Obstacles and facilitators were found for each (Fig. 6).

4.3.1. Interactions with teachers

When asked about their interactions, TTs primarily discussed their exchanges with teachers *(164 references as facilitator and 80 references as obstacle)*. Facilitating interactions described by the TTs included: positive feedback, witnessing engagement and motivation, showing empathy, promoting mutual trust, giving the training in teachers' environment, and following-up with them over a long period of time. Difficult interactions included: teachers' complaints about the difficulty of the training, its utility or the struggle to use the training in their daily practice. The TTs also reported the difficulty in motivating both the teachers closest to retirement and the youngest teachers who consider that they do not need this training because of their presupposed knowledge of technology: *"They have the impression of knowing everything and that we have nothing to teach them. There was one who was on her phone all morning and didn't participate at all." (Jacques)*.

4.3.2. Interactions between the tandem and with others TTs

The relationship between the members of each tandem was also discussed *(92 references as facilitator and 8 references as obstacle)*. The TTs described the necessity of being able to rely on their partner and the positive consequence of being trained together: *"We get along well, it's good. I know we can work together. And above all, we will be able to build something over time." (Leonor)* The relationship with the whole group of TTs was also seen as a facilitator *(47)*: *"We are part of a big family. We could sit next to anyone and find something to talk about. I know there will be no tensions as we come from different cycles and different schools." (Margaux)*. It was never described as a barrier.

4.3.3. Interactions with expert trainers

Expert trainers' interactions represent 47 facilitating references and 35 hindering ones. The TTs described the importance of support founded on honesty, trust, encouragements, technical help, trail training session etc …: *"The visit of our expert trainer is very reassuring. She is caring and gives very good advice." (Margaux, in her portfolio)*. On the other hand, 35 references about these interactions being some obstacles were also noted (such as a lack of up-to-date documents, problems in the tandems creations, a lack of clarity regarding the creation of teachers' groups …). One factor was eagerly discussed during an intervention of an expert from the Department of education who, after having observed several pairs in training, noted differences in the way the tandems gave the training: *"If the department wants us to use the exact same words, they must write our text and we learn it by heart. But that's not how I want to participate in this innovative project!" (Enora)*.

4.3.4. Interaction with school stakeholders

References in terms of obstacles and facilitators were almost equal (50 references about obstacles and 55 about facilitators). The TTs talked about having very neat and well-organized welcomes, and some catastrophic conditions where they sometimes had no room, tables, video projection systems or even heating systems set up for them. In this case, the TTs pointed out a problem of recognition: *"We arrive with a lot of requirements on the material and the time devoted to this training and finally we do not have the recognition as [expert] trainers would have." (Enora)*. Interactions with digital instructional coaches during the teachers' training sessions are also valuated: *"We were lucky to arrive in two schools where the coaches were present at all the training sessions. It was extremely rich. They wanted to be there to identify the teachers, to know them, to know who is going well and who is not." (Astrid)*.

5. Discussion

The goal of this study was to explore the factors perceived as barriers or facilitators by teachers endorsing the role of TTs in a digital education school reform. The experience of these 14 TTs sheds light on the elements that impacted their experience. We have shown that implementing a cascading train-the-trainer model is a complicated process on multi-levels that necessitates coordinated efforts to identify barriers and facilitator, whether institutional, organizational, temporal or intra/interpersonal. Results were presented following the different training levels of the project. Four categories (individual characteristics, interactions, content and logistic) of factors were then identified and are discussed in this section.

5.1. Individual characteristics

The current study identified individual characteristics as crucial variables in the selection of TTs for DE training program. These variables included current teaching experience, adaptability, adult training expertise, and content knowledge. A phenomenological perspective was adopted, which emphasized the significance of motivation, self-efficacy and feeling of recognition. These findings align with the results of previous studies such as Bax (2002), who highlighted the importance of credibility and confidence in TTs. The TRAIN framework proposed by Mormina and Pinder (2018) supports the notion that *talent* is a crucial
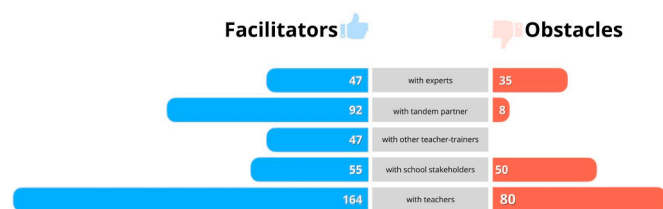

Fig. 6. Number of thematic references about obstacles and facilitators made by the TTs when talking about the interactions they have with the project stakeholders.

Facilitators 👍		Obstacles 👎
47	with experts	35
92	with tandem partner	8
47	with other teacher-trainers	
55	with school stakeholders	50
164	with teachers	80

factor in selecting TTs with professional experience.

Moreover, the study results advocate for TTs to maintain their teaching roles alongside their training duties. This "double hat" approach closes the gap between TTs and teachers (Bax, 2002) and contributes to the formation of a community of practice, essential for effective implementation (Attard Tonna & Bugeja, 2018). In the context of digital education, however, content knowledge may not be a crucial selection criterion, as new technical skills can be acquired through training, considering the time required for TTs to appropriate them. The *nurture and development factor* (Mormina & Pinder, 2018) highlights the importance of providing TTs with opportunities to express and share their experiences, thereby facilitating the development of the soft skills necessary for their professional development as trainers.

5.2. Interactions

In the job development investigated, multiple interactions were identified as major facilitators for the newly appointed TTs. The TTs felt that positive and negative feedback from expert trainers and teachers influenced their learning process. These results are coherent with Mormina and Pinder (2018)'s *nurture and development* factor that recommend collaborative work and partnership between stakeholders. In the context of digital education, teachers' initial beliefs about digital integration could benefit from TTs' personal experience.

The findings in this study also indicate the importance of collaboration and support given within the TT tandems. Indeed, these are considered to influence TTs' motivation to continue or not with their mission. Research on co-facilitation has indeed stressed the importance of collaboration between trainers in the TPD context (Cohen & DeLois, 2002; Galinsky & Schopler, 1981). This result may suggest a potential attrition if tandems are not trained to be effective with other partners.

Finally, TTs emphasized the importance of a positive relationship with school stakeholders. These results are coherent with the recommendation pointed out by Ngeze et al. (2018) who advocated for the support of experts and regular debriefing between peers during the integration phase. In our context, TTs' feeling of collaboration with instructional coaches assigned by the Department to welcome and assist them within the school, changed significantly between schools. These differences may explain the rather negative comments TTs made about collaborations with school stakeholders.

5.3. Contents

This research highlights the significance of developing the teaching content, the delivery methods used by teacher trainers (TTs), and the time allocated for them to appropriate the content. This finding aligns with previous studies that emphasize the importance of hard skills for TTs (Ngeze et al., 2018; Chatziefstathiou & Phillips, 2011; Ng & Lam, 2015) and the concept of "transfer ownership" in the implementation factor of the TRAIN framework (Mormina & Pinder, 2018). The results indicate that TTs perceive the need for sufficient appropriation time, which could be due to their relatively novel experience in teaching digital education.

The alternation between TTs receiving training from experts and training teachers is also a significant result of the study. This approach provides TTs with support, feedback, and continuous opportunities for content appropriation. It is worth noting that the impact of the Covid-19 pandemic was also taken into consideration. The pandemic resulted in postponing teachers' training sessions, which gave the TTs more time to prepare before assuming their role as adult trainers. The results also suggest that TTs feel the need to take ownership of the teaching content, which requires adequate preparation time and high-quality training. This desire for ownership is linked to the motivational aspect of job development, as evidenced by the TTs' desire to be more than "parrots" in this innovative project. To assess the implementation fidelity, further investigation through expert observation and feedback is necessary.

5.4. Logistics

The role of technical and infrastructure efficiency has been highlighted as a dominant factor that requires constant attention and management, as material efficiency is a key facilitating condition in DE reforms (Schleicher, 2018, Ch. 5). Our findings suggest that TTs perceive these factors as barriers to effective training, rather than facilitators. In line with previous research on the qualities of a good TT (Chatziefstathiou & Phillips, 2011), our results highlight the importance of adding "debugger" to the list, as managing technical problems is a significant part of the training process. TTs must be equipped to handle unexpected technical issues to ensure effective training. While previous research has emphasized the importance of organizational skills for TTs (Kandiller & Özler, 2015; Chatziefstathiou & Phillips, 2011), our findings suggest that delegating some these tasks to expert trainers could allow TTs to focus more on building relationships with teachers and delivering the training.

Furthermore, multi-leveled reflections, as described in the TRAIN framework (Mormina & Pinder, 2018), must be considered under the *resource factor and context factor* to ensure organizational support among all project stakeholders, including those in other institutions and the department of education who are responsible for financing the project and allocating physical resources.

6. Main limitations of the study

This study has several limitations that could prevent the generalization of the findings. First, the sample size is small (14 participants). Therefore, these results, although providing a first indication of the main obstacles and facilitators need further validation (for instance with other TTs involved in deploying the reform to other grades).

Second, obstacles and facilitators may vary over time and across the different phases of the learning process. Although we tried to diversify the data collection (focus groups and portfolios), some obstacles may have been overlooked for different reasons. In particular, information seen as too personal or sensitive due to social norms may not have been discussed during the focus groups (e.g., the issue of remuneration). These factors should nonetheless be accounted for as they could have had a significant impact on the TTs' experience.

Finally, further investigation is required across levels (our study focused only on K-3 TTs training) and with a more heterogeneous sample of participants to confirm and complement these preliminary findings.

7. Recommendations for practitioners

The results of this study emphasize the important role played by expert trainers in the development of TTs. In particular, the findings focus on specific considerations relevant to the implementation of digital education programs using TTs. To facilitate the replication of such programs, it is recommended to integrate these findings with existing frameworks, such as the TRAIN framework by Mormina and Pinder (2018) and the systematic review conducted by Snowden et al. (2022), to ensure effective implementation.

7.1. Personal characteristics

- TTs should have current teaching experience in the same context as the teachers being trained. This would enable them to use and test the training contents in their classes and share a common experience with teachers.
- Former experience in terms of adult and digital training are important and should be either considered ad prerequisites for recruitment or formally taught during the TTs' training sessions.

7.2. Interactions

- Experts should monitor TTs throughout alternate moments of training and observations giving qualitative and quantitative feedback, providing personal experience and advice to adjust and personalized their feedback to the TTs needs and context.
- Expert trainers should facilitate meetings and interactions between TTs and school stakeholders to ease the communication and provide the development of effective community of practice.
- Expert trainers should pay particular attention to teambuilding and strong partnership support between TTs members and between them and TTs.

7.3. Content

- Expert trainers should take into consideration the TTs' sense of ownership by giving them substantial preparation time and allowing them to add personal touches to the training content (fidelity of implementation must therefore be carefully monitored).
- Expert trainers and TTs should collaborate when content need to be discussed or adapted.

7.4. Logistics

- Organizational support should be provided by expert trainers throughout the entire training program in terms of training schedule, technical equipment and infrastructure.
- Tandems of trainers should be considered because of the support provided especially in the demanding context of digital education.

8. Conclusion

The implementation of a cascading TTT program is a complex and multifaceted process involving not only the optimization of logistics, personnel, and training resources, but also a fine comprehension of subjective factors such as learning experience, motivation, interpersonal relationships and perceived legitimacy to train teachers. To this end, this article focused on the lived experience of 14 TTs to better understand what factors facilitated and what factors hindered their mission. The qualitative analysis outlined the main obstacles and facilitators which were classified under four dominant themes: 1) individual TT characteristics, 2) instructional content, 3) interactions between stakeholders and 4) logistics. These results were discussed in the context of a digital education reform. Based on the findings, concrete recommendations are provided to help training designers in their conception of large-scale TPD in digital education using TTT programs.

CRediT authorship contribution statement

Emilie-Charlotte Monnier: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft, Visualization. **Sunny Avry:** Methodology, Formal analysis, Writing – original draft, Visualization. **Laila El-Hamamsy:** Investigation, Data curation, Writing – review & editing. **Caroline Pulfrey:** Investigation, Writing – review & editing. **Christiane Caneva:** Writing – review & editing, Supervision. **Francesco Mondada:** Writing – review & editing, Project administration. **Jessica Dehler Zufferey:** Writing – review & editing, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A

Data type	Data source	Date	Topics	Questions	Participants
Exploratory phase					
Collaborative portfolios					
Qualitative	1 to 14	Aug 20-June 21			14
Focus groups					
Qualitative	Focus group 1 (FG1)	15.12.20	Debriefing about the content and the use of the collaborative portfolios and the feedback received by expert trainers	Can you describe the personal experience you had with portfolio assignment?	1 × 6
				Follow-up questions: How much time per week did you spend on the portfolio? How did you use your portfolio? For which purpose? Did you find the expert feedback useful and why? How did the portfolio make you more comfortable with the tablet? How do you feel about the upcoming teachers' session?	1 × 7
Qualitative	Focus group 2 (FG2)	23.03.21	Emergent themes	Can you describe the personal experience you had during? 1) the first TT training session? 2) the first days of training in the schools as trainer? Follow-up questions: what went well? what went less well? what needs to be adapted?	1 × 8 1 × 6
Qualitative	Focus group 3 (FG3)	25.05.21	*Data-driven questions* Emergent themes of FG2 Content (top, flop, modification) Context (school, admin, organization, group)	Can you describe the personal experience you had since our last focus group regarding the following themes? Did you experience something new? Do you have other comment?	14

(continued on next page)

(*continued*)

Data type	Data source	Date	Topics	Questions	Participants
Qualitative	Focus group 4 (FG4)	14.12.21	Timing (management, differentiation) Relevance and audience Relationship (with teachers, PRs, other EFs, pair) Teacher reactions EF training (content, desires, needs, recommendations) *Theory-driven question* Motivation (Legitimacy? Self-efficacy? Attrition?) Training content (Dilution? Ownership?) Peer support/experts' feedback Etc.	What do you think about the following subjects related to the experience you had as teacher-trainer?	1 × 6 1 × 7
Validation phase					
Quantitative	Questionnaire 1 (Q1)	25.04.22	Participants validation	From the various focus groups and logbooks, we have identified 19 factors that have complicated/facilitated your experience as TTs. How much do you think they reflect what you have personally experienced?	13

Appendix B

Factors perceived by teacher-trainer contributing to a successful train-the-trainer digital education program.

Factor number	Negative Experience with factor Example quote (translated from French)	*Number of references*	Factors	Positive Experience with factor Example quote (translated from French)	*Number of references*
TTs talking about the training sessions for teacher-trainers					
Training characteristics					
1	"What reassures me is the team of trainers because I greatly appreciate the quality of the theoretical basis that we receive but also all the little tips and feedback in the portfolio." (Axel, in his portfolio)	*30*	**Training content**	"It was so difficult at first, so time consuming to understand everything we were shown. We tested, we scratched, we watched tutorials. It took an unimaginable amount of time." (Margaux, focus group 4)	*34*
2	"I think we were extremely lucky to have an extra year of preparation (ed: because of COVID). If I hadn't had that year, I would have felt uncomfortable because I wouldn't have had the impression of mastering the content." (Christiane, focus group 4) "But the advantage is that we really had time to see it all. We l had the overall vision of what we had to do. This allowed us to regulate the training during the morning." (Astrid, focus group 2)	*60*	**Appropriation time**	"The content of our training is very ambitious and frankly it already takes me a long time to master the content. If I hadn't had that time, I would have stopped I think." (Joelle, focus group 4)	*16*
Personal characteristics					
3	"This legitimacy, we hold it because we were chosen for this position. But in relation to the adults we train, legitimacy is also the credit they are willing to give us. And it is also our experience, at some point, which will reinforce this legitimacy." (Francis, focus group 4)	*27*	**Feeling of legitimacy**	"I had trouble feeling legitimate at first, because I come from cycle 3 (ed: students between 12 and 15 y. o.) and therefore at first, my posture was a bit different. (Astrid, focus group 4)	*31*
4	"All this, allowed me (…) to be ready and motivated for January (ed: first day of teacher training)." (Sarah, in her portfolio)	*58*	**Motivation**	"We all started this project with a lot of motivation. But it is true that the salary issue should not be put aside and avoided. There is a big difference in salary between grade 9 and 12." (Joelle, focus group 4)	*18*
5	"It was positive feeling credible and capable. I knew where I was going, and I knew I could do it. (Astrid, in her portfolio)	*53*	**Self-efficacy**	"The first morning of training, when there were a lot of things to manage at the same time. My mouth was dry. I said to myself, there is still all the text of this slide, it is still quite important. I won't make it to the end …. (Axel, focus group 2)	*35*
6	"It's different to train adults than children. I'm used to being on stage, it helps me a lot and I was finally able to drop my notes. I gain fluidity. (Samantha, in her portfolio) "I was lucky enough to have both functions: to be instructional coach and in a pilot school. I had already experienced all that. So, I only talk about things I've done in the field." (Josephine, focus group 2)	*38*	**Adult trainer and content skills**	"We are actually not really trainers. Because we give training designed by other trainers. It skews the question. I have the impression that we are like spokespersons." (Francis, focus group 4) "I find that our training lacks a bit of how to behave with adults." (Jérôme, focus group 4)	*42*
7	"I think that when we tell them, when we introduce ourselves, that we are teachers like them, that means a lot." (Francis, focus group 2)	*39*	**Teaching experience**		-
TTs talk about the interactions experienced with the project stakeholders					

(*continued*)

Factor number	Negative Experience with factor Example quote (translated from French)	Number of references	Factors	Positive Experience with factor Example quote (translated from French)	Number of references
8	"The visit of our expert trainer is very reassuring. She is caring and gives very good advice." (Margaux, in her portfolio)	47	**with the project experts**	"The first day, it was not easy to have an expert watching us. You haven't done the training yet. You don't know how it's gonna turn out, how it's gonna go? And you already have someone watching you! (Axel, focus group 2)	35
9	"Finally, we were able to give our first day of training. What a great experience! I'm very happy to be with Jacques, he's nice, he doesn't judge me and is always in a good mood. He supports my humor and that still requires a lot of patience!" (Eleonore, in her portfolio)	92	**with training tandem**	"How to talk about it with her when I'm her partner and not an expert?" (Astrid, in her portfolio)	8
10	"I think all we've been through together has really been a benefit for the team because we've had to know each other. We've been through things and struggles together, and I think we developed a strong bond." (Samantha, focus group 4)	47	**with other teacher-trainers**		-
11	"I try to use empathy and tell them that I don't have it all figured out either." (Eleonore, focus group 4)	164	**with teachers**	"Some young teachers, it's a bit worrying. They have the impression of knowing everything and that we have nothing to teach them. There was one who was on her phone all morning and didn't participate at all." (Jacques, focus group 3)	80
12	"We were lucky to arrive in two schools where the coaches were present at all the training sessions. It was extremely rich. They wanted to be there to identify the teachers, to know them, to know who is going well and who is not." (Astrid, focus group 3)	55	**with school stakeholders**	"For the whole organization of the day, we completely depend on them. Room reservations, tables, equipment, parking, video projector … If it's someone with whom you don't have a good connection or someone who isn't involved at all, the day is already compromised." (Christiane, focus group 4)	50

TTs talking about the training sessions for teachers by teacher-trainers

Technical characteristics

13	"A nice video projector and an Apple TV already plugged in and ready to connect. Perfect!" (Josephine, in her portfolio)	17	**School infrastructure**	"We were assigned a classroom? that was no longer in use. There was no heating. In fact, there was no screen either. (Melissa, focus group 3)	44
14	"We took our own video projector with us to be prepared for all situation" (Melissa, focus group 3) "Some technical problems have been solved by the school IT guy and the trainer of CODE (ed: state IT support)" (Joelle, in her portfolio)	11	**Technical infrastructure**	"Big technical problems in this class: impossible to connect video projector and Apple TV. We don't have the right cables and the video projector is too old! We try with the classroom computers. They don't want to recognize the Apple TV … (Jacques, in his portfolio)	67

Teaching characteristics

15	"There is some content that we could not present as planned. We had to completely change the presentation and do it again according to what we considered to be the teachers' needs in cycle 1." (Josephine, focus group 4)	58	**Content**	"No, I don't think I'm diluting the content. On the contrary. I add information, I create links. In fact, the better I master the material, the better I manage to create links with things that have already been seen, with things that will come. But the problem is, I think the content is worse on the first day than on the last!" (Astrid, focus group 4)	44

Organizational characteristics

16	"We know the teachers. They know us. We eat lunch with them. It is important to follow them through the training days." (Jonas, focus group 4) "Change of partner (I'm starting to get used to it). I didn't expect to have so much flexibility and adaptation, but I think it was a great experience to train teachers with different people." (Sarah, in her portfolio)	4	**Stable TT tandem**	"It is important to have this flexibility. If things go wrong with a group of teacher-trainers in a school, we need to be able to exchange (Josephine, focus group 4) It takes a lot of time and energy to prepare for the training days. If we had to team up with different teacher-trainers each time, we would have to start the work over again and lose our momentum. (Christiane, focus group 4)	22
17	"More experienced teachers could, in my opinion, "coach" their new colleagues towards a more positive approach to training." (Axel, in his portfolio)	11	**Heterogeneous groups**	"After the training we were told that it was not suitable enough for those who had ease and that they were bored." (Josephine, focus group 2)	7
18	"There is a natural connection in small groups. When you come and sit next to a few unmotivated, not interested in technology people and say: "now we're are doing it together". Nobody says no." (Jacques, focus group 2)	25	**Small size group**		-
19	"We adapt our flow to the understanding of the people we have in front of us. Because sometimes, we see eyes widening or closing. It's true that the density of the content is often too dense for what people can absorb." (Sarah, focus group 4)	28	**Adaptations to the context**	"The time must be adapted to each group. It completely changes every time. The fact that we were given a timing is difficult to manage. (Christiane, focus group 2)	39

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