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Developing a mentoring programme in the chemical industry: From conceptual development to implementation follow-up

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Developing a mentoring programme in the chemical industry

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Abstract

Purpose – The purpose of this paper is to analyse a programme designed to welcome and train new employees, implemented in a chemical industry, privileging the transmission of know-how as a dynamic process where learning is co-constructed in the course of the activity.

Design/methodology/approach – The design of the programme was based on the analysis of the work performed in real context by operators and supervisors. The data about the programme's evaluation were collected by questionnaire, assessing the trainees' global development and the impact of the training programme (after six months).

Findings – This paper involves designing, planning and implementing "4 × 4 Training", a training programme for young trainees. Combining in-class training with an extensive component of on-the-job mentoring, the programme involved trainees, mentors and internal trainers, monitored by work psychologists. The results show both the trainees and the mentors evaluate the programme positively. The professional transmission stands out as an activity that is thought through and defined in group, assisted by a mentoring relationship of mutual learning.

Practical implications – When planning and developing intergenerational transmission processes, it is crucial to consider the organisational conditions, to involve from an early stage the key players of each work situation and to guarantee that the mentoring activity and the productive activity overlap coherently.

Originality/value – It is an innovative process to integrate trainees in the chemical industry in Portugal. The methodological approach and the findings provide a first framework that justifies the relevance of the transmission of know-how through a real work situation.

Keywords Mentoring, Workplace learning, Chemical industry, Experienced workers, Transmission of know-how

Paper type Case study

1. Introduction

Over the past couple of years, the issue of know-how transmission is being highly appreciated not only at a scientific level, but also in the work contexts; nevertheless, specific ways to operate the transmission have not been made available. The inevitable concerns that emerge are related to the identification of the know-how to be transmitted, who may transmit it, at what moments and under which conditions. These concerns are even more relevant when we are facing complex and dynamic work environments, where the learning process is long and demanding.

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Therefore, this paper aims at presenting and analysing the process to build a programme for the integration, training and development of know-how of the new workers of a Portuguese company from the chemical sector.

The programme's central structure relies on a mentoring component, the pairing of experienced workers (older employees acting as mentors) with trainees (younger employees, as mentees). A particular emphasis is given to the transmission as a process accomplished during, through and in the work activity. In fact, we will address the transmission of know-how as a process where the learning is co-constructed in work situations, through the activity deployed in the real conditions. The organisational and productive conditions that support the development of know-how, in a chemical company whose age average in the production team is 48 years old, are also taken into consideration. Given this context, characterised additionally by the concern with an eventual drain of relevant competencies in the short term, it was then outlined and implemented a mentoring programme designed to encourage the transmission of know-how among workers from different generations.

2. The current demographic configuration and the work evolutions

Over the past decades, the demographic evolution is definitely on the agenda because it registers a sharp reduction in the proportion of young people and a significant increase in the number of working-age people and in the number of elder people (60 years old and older) (United Nations, 2017). In terms of human resources (HR) management, this demographic transformation poses new challenges to the companies. One of the main challenges is precisely the management and transmission of competencies from the elder and more experienced workers to the younger ones, to assure a continuum in the organisational competitiveness (Farr and Ringseis, 2002; Streb, Voelpel and Leibold, 2008). Thus, the companies have been implementing several responses, some closer to the "intergenerational learning" programmes (Ropes, 2014), others related to "knowledge management" mechanisms, particularly those regarding the capture and transmission to retain knowledge within the organisation (Calo, 2008).

Nowadays, the companies' situation is marked not only by the "demographic reconfiguration" (Volkoff, 2011), but also by transformations concerning the work itself and its organisation: the strong time constraints; the increased workloads; the spread of precarious employment conditions; or the demand of higher levels of multitasking and flexibility from the workers (Green, 2004; Gaudart, 2015).

Given the on-going changes regarding demography and work, it is important to refocus the analysis on the options the companies choose to guarantee the transmission of know-how among different generations of workers. This is so more relevant when several discourses (Harvey, 2012) anticipate a "corporate amnesia" associated with the retirement of a large number of experienced workers.

3. Theoretical background

3.1 The mentoring-based transmission

Over the past few years, as a result of the development of technological tools, the supporting strategies and tools for the transmission are multiplying in the organisational contexts. Given its broader range, institutionalisation, empirical evidence and support from public policies, unions and pedagogical subjects, mentoring emerges as the most common strategy to guarantee the transmission of know-how, in a relationship that is supposed to be beneficial for both the senior and the junior worker. As such, in the light of the most classical versions (Kram, 1983), a mentoring process involves in a relationship a more experienced element (expert) and a younger element (newbie), who receives support, direction and

protection from the more experienced worker. Therefore, the purpose of the mentoring process is twofold (Swap, Leonard, Shields and Abrams, 2001): socialisation or integration (sharing experiences between workers); and internalisation ("learn by doing").

In this type of relationship, the more experienced worker leads the way through the learning process. The mentor mediates, monitors and enhances what the younger worker learns, by getting actually involved in the daily work tasks (Billet, 2000). Consequently, such mentoring processes privilege a "situated approach" (Thébault *et al.*, 2012; Ledoux *et al.*, 2012) or a "situated learning", that is, the learning is merged with the development of the work activity. Consequently, the newcomers reveal a constructivist nature of learning (Illeris, 2003); in other words, learning the professional content in a specific working context is taken as a process to build competencies. According to Paloniemi (2006), this process is necessarily context-related and cumulative, following the work activity.

Even though this activity is structurally defined by a mentoring relationship, by giving priority to the transmission of know-how during and through the work activity, it is crucial to underline the role played by the group of co-workers. The transmission between the mentor and the mentee is mediated not only by the work situations – where the competencies are developed – but also by the work team (Delgoulet and Vidal-Gomel, 2015). For that reason, the team emerges as a vital resource for the transmission; it contributes to transform the work situations into real opportunities for the newcomers to learn. It is in the team that the productive tasks are redistributed so to favour the "constructive activity" between mentor and mentee, but it is also the group that shares with the younger workers the "rules of the job", the self-preservation know-how and the norms ruling the work situations (Delgoulet *et al.*, 2012a, 2012b; Thébault *et al.*, 2014). In fact, welcoming and following the newcomers in the first moments of contact with the work environment are also moments when the senior workers re-question the work. The newcomers look at the work situations and their rules with new lens, and as such, they can question the expertise and the practices in force (Mariani and Parlangeli, 1999; Billet, 2001), compelling the more experienced workers to a reflexive activity about new action systems and other tools to the re-appropriation of the work environment (Wittorski, 1996).

3.2 The training of newcomers in chemical context

Using mentoring programs to train new workers on-the-job is receiving attention in different activity sectors. Notwithstanding, the industrial contexts with high levels of safety requirements stand out, for instance, nuclear, electrical or chemical (IAEA, 2006; Le Bellu, 2016; Chen, 2016). With the retirement of the older workers just around the corner, these organisational contexts reveal strong concerns regarding the possibility of knowledge loss, especially knowledge on risk management at work and safety in the operations. Considering the chemical context in particular, programmes to integrate newcomers tend to combine two training moments: an initial stage of theoretical training (in class), quite often to address basic technical knowledge and health and safety rules; and a second stage, when each newcomer can be accompanied by a mentor/supervisor (on-job training) (Gaudart *et al.*, 2012; Mariani and Parlangeli, 1999). Usually these programmes limit the learning and the transmission from the experienced workers to the newcomers to relatively short periods, from three to six months. By the end of the training, the junior workers are expected to be completely autonomous in the chemical operation (in the control room or outside the chemical facilities).

Moreover, in the context of chemical production, the newcomers' learning process may be subject to operational goals, even more than to educational goals (Mariani and Parlangeli, 1999). Hence, during the training period, the newcomers contribute to the production

activity, though it is not guaranteed that they will be hired. That decision depends upon the evaluation towards the end of the training period. For that reason, Gaudart *et al.* (2012) underline the "moral contract" between workers may be broken: the senior worker guides and monitors the junior's learning, hoping the latter will join the group and succeed the mentor.

3.3 The contribution from activity-centred ergonomics and work psychology

Despite the substantial stability around the roles played by a mentor and a mentee, both those who coordinate the integration and training processes and the players directly involved, identify certain difficulties in gaining access to the rich experience and efficient know-how accumulated by the senior workers.

When addressing the topics about the development of competencies and the intergenerational transmission of know-how, the contribution from work psychology for the multidisciplinary project launched by the activity-centred ergonomics (Falzon, 2015) refocuses the analysis on the role played by the work activity and the mediation in the workplace learning. Thereby, in line with the scientific tradition in work psychology (Lacomblez *et al.*, 2007), we are not interested in finding the ways the motivations and/or aspirations of the players (mentor and mentee) contribute or not to maintain the organisations' social climate (Collins and Smith, 2006). Hence, in this paper, we address the exchanges of professional expertise between workers from different generations, relying on the notion of professional transmission, considered as a process that goes beyond transferring or sharing; in fact, it implies a joint construction through practice by the workers (Ouellet and Vézina, 2009).

Bearing this in mind, the activity transmission consists in a set of exchanges about professional practices, occupational values, "tricks of the trade" and know-how combination while the work is being performed. It happens with workers with different paths, backgrounds and ages (Cloutier *et al.*, 2012; Thébault *et al.*, 2014). It goes beyond the expository transfer or the sharing process between social units (one source and one receiver), where they tend to be highlighted as disseminative capabilities of the mentors or as absorptive capabilities of the mentees (Nan *et al.*, 2013; Argote and Fahrenkopf, 2016). Quite the opposite, the transmission is a process where the learning is part of the development of the work activity, in a real context, where, through practice, the mentor transmits to the mentee not only "what to do" but also the "why" and the "how" to do it (Ouellet and Vézina, 2009). Therefore, according to Billet and Choy (2013), it is precisely because of the performance of the activity in context that the experienced workers get to explain the criteria to assess and evaluate the situations, justifying the options taken in those settings, hence allowing the less experienced workers to extend their knowledge.

Adopting this vision about the transmission inherited from the ergonomic approach, as an activity that overlaps the work process, brings along two implications. On the one hand, it implies the recognition about the previous analysis, planning, structuring and necessary surveillance, in an effort that attempts to provide a coherent support to the integration of new workers and assist the development of know-how required for effective work practice in those settings (Billet and Choy, 2013). On the other hand, our interest is the transmission of "efficient know-how" (Ouellet and Vézina, 2009) or also known as "experiential knowledge" (Cloutier *et al.*, 2012). This type of knowledge, quite often invisible and hard to reach, is related to the information the more experienced workers use to meet the production demands (production aspect) and, at the same time, to preserve their health and the health of their mates (preventive competencies) through "know-how of caution" (Cru and Dejours, 1983). This type of knowledge comprehends such diversity and wideness that it is necessary

to underline that the transmission is also a major process of knowledge assimilation, integration and transformation. This means that the less experienced workers feel empowered when the knowledge is passed on through the construction (in practice, in the performance of the activity in context) of their own "professional style" (Clot, 2008). Such "style", once debated and validated by the work group, represents a practical knowledge that allows the least experienced to develop effective and safe actions regarding that particular context. Consequently, the ongoing learning from newcomers cannot be split from context, which compels the necessary assumption of a "learning-as-participation" perspective (Sfard, 1998). Under the scope of the ergonomic approach, the overall positive effects of the workers' participation (with different levels of seniority) in the planning and control of their work activities is stressed (Burgess-Limerick, 2018). As such, in line with this tradition, the transmission of know-how is marked by the dialectic, cooperative and participative nature of learning, considered as the process that enables the least experienced to become "community members" (Sfard, 1998) – in this case, a work community. The more experienced workers get to guarantee the preservation and renewal of their professional milieu, through the integration and follow-up of the newbies.

Inscribed on this theoretical and procedural framework, several studies are showing that the transmission between a mentor and a mentee is a dynamic, evolutional and bidirectional activity, hence offering the possibility for a mutual learning process (Thébault *et al.*, 2014; Cloutier *et al.*, 2012; Delgoulet and Vidal-Gomel, 2015; Naweed and Ambrosetti, 2015). Such relationship, between workers with different levels of experience, is started and continuously co-constructed given not only the edification of a double path to share know-how, but also the accomplishment of reflexive activities together. In this regard, Weill-Fassina and Pastré (2007) point out that it is not possible to learn everything through action, because the inexperienced workers can be put in complex situations that require the coordination of multiple dimensions, information or objectives. As such, the professional competencies are "permanent constructions in relation to the context" (Re, 2008), developed while the action is taking place in the workplace, but also afterwards, that is, through "metafunctional or reflexive activities" (Falzon and Mollo, 2009).

The challenge relies, then, on the creation of professional transmission devices that are broad enough to encompass room for the construction of competencies while the work is being developed in context, as well as moments to reflect upon the action, for both the senior and the junior worker.

4. Methodology approach

4.1 The request for the research action and the description of the context

The training programme took place in a company from a chemical facility, located in the Central Region of Portugal. This company encompasses 10 plants, distributed by two clusters of chemical production responsible for the production of organic and inorganic compounds. The company's production area is organised in three rotating shifts, keeping a continuous operation 24 hours a day. Each production cluster has a foreman in charge of a team of 10 operators (two operators per plant). Overall, at this company, each plant has a panel operator, who is responsible for controlling the automation of the production process in the control room, and an outside operator, who is responsible for supervising the production on-the-spot and the quality control.

To this day, the company employs around 220 workers; the average age at the production area is 48 years old and around 12 per cent of the workers are over 60. Given this demographic scenario, the company decided to hire 10 trainees for the production area, who would take on a new position, "Industrial Chemistry Technician" (ICT). With the creation of

this position, the company wanted the 10 trainees to develop professional competencies that would give them flexibility within the activities of the production area, which so far belonged to two different groups of workers: panel operator and outside operator.

Considering the concerns regarding the company's demographic evolution, which was leading to an eventual loss of expertise, together with the desire to encourage the transmission of experiential knowledge, the following objectives were established for the programme:

- to create the right conditions to favour the involvement of workers with different backgrounds, positions and age ranges in the fulfilment of the transmission;
- to foster a broader intervention scope for the new position as Industrial Chemistry Technician;
- to promote the progressive rejuvenation of the production team; and
- to provide the trainees the opportunity to learn while performing the activity in context, counting on the guidance offered by the senior workers.

The company's Human Resources team together with the team of external consultants were responsible for setting these objectives[1].

4.2 Participants

The programme directly involved trainees, internal trainers (employees from different job positions) and mentors, all of them foremen. Table I summarises the main characteristics of these elements.

4.3 Procedures and preparation for the programme 4 × 4 training

The training programme designed and implemented in the company at stake, during an entire year, is called "4 × 4 Training", to express as goals the acquisition and development of competencies regarding the operation in the control room and the work outside, consequently, a crossover approach[2].

The preparation of the programme implied a close contact between the team of independent consultants and the company's HR team to build a tailor-made programme structured to meet the company's specific context and needs. The programme should also provide an answer to the following questions: which know-how do we want to transmit; who may be the stakeholders to transmit that know-how, when and how to do it?

At this stage, for the preparation and design of the programme (Table II), and focusing on data collection process, the external consultants took some time to analyse documents and analyse the work (Lacomblez *et al.*, 2007; Delgoulet *et al.*, 2012a, 2012b) performed by

Participants' status	Gender M	Gender F	Average age	Position
10 Trainees	10	0	28	Industrial Chemistry Technicians (double expertise: panel operator and local operator)
36 Internal trainers	25	11	45	Production Coordinators Maintenance Coordinators Senior Security Technicians Analytical Control Coordinators
10 Mentors	10	0	53	Production Foremen

Table I.
Characteristics of the elements directly involved in the training programme

production foremen and operators. Then they had access to the necessary information to get to know and describe the work. This stage turned out to be determinant for the construction of the activities the trainees and the mentors were invited to do in class (e.g. possible scenarios related to the production area; reflection about aspects in favour and constrains that may be found on the field). The reasoning thereto was using the work analysis as an instrument to create training resources (Lacomblez, 2001).

At this early stage, there was also the organisation of a focus group with all the internal trainers to do a joint systematic approach to the contents addressed during the training.

4.4 Elements of evaluation

In addition to the follow-up and assessment meetings held throughout the programme, formal evaluation moments were also established to assess the 4 × 4 Training. The primary evaluation elements correspond to data collected from the instruments that were created specifically for this purpose: final evaluation questionnaire about the development of the trainees by the mentors; programme's evaluation questionnaire by the trainees; and questionnaire to evaluate the programme's impact by the trainees and mentors (six months after the end of the programme). The answers are assessed on a five-point Likert scale, where 1 corresponds to "insufficient", 2 to "sufficient", 3 to "good", 4 to "very good" and 5 to "exceptional".

5. Findings

5.1 Design of the programme 4 × 4 training

The programme designed from scratch combines two stages at the training level:

(1) On the box stage that encompassed a set of in-class training sessions; and

(2) Off the road stage that took place at the workplace, where the trainees joined work teams; the trainees were formally given a mentor whose mission was to follow and guide the younger worker.

It is worth mentioning that the 4 × 4 challenge happened at this last stage, a moment dedicated to the definition of suggestions to intervene and improve the working conditions.

The intervention of the work psychologists – external consultants – in both training stages addressed three different stakeholders: internal trainers, trainees and mentors. The involvement of these three players aimed at thinking through the scientific and experiential knowledge to be shared, guaranteeing coherence in the transmission between seniors and newcomers.

5.1.1 The transmission of contents in class: on the box stage. This is the first training stage and it corresponds to the organisation of in-class training sessions. It took place along two months with internal trainers who stood in different positions within the company (e.g.

	Components	Participants	Methods and purpose
Previous work analysis and preparation	Set-the-track	Panel and outside operators Internal trainers Mentors	Documentary analysis and ergonomic work analysis, carried out by the research team (work psychologists) Definition and joint validation of the programme's needs, objectives and stages

Table II.
Description of the programme's preparation stage

Coordinator for analytical control, Senior Safety Technician, Production Coordinator), selected according to their areas of expertise and the knowledge to be passed on to the younger workers (e.g. Hygiene, Occupational Safety and Health, General Chemistry, Maintenance Management).

During this stage, the trainees had daily training sessions with the internal trainers, a methodology to provide them the necessary theoretical contents for the performance of the job as ICT. A few milestones were set for the trainees to answer theoretical exams. These exams made it possible to verify whether the knowledge was being apprehended and whether the interns were ready to follow to the next stage.

This was the very first time the employees were acting as internal trainers and the Production Foremen were acting as mentors (at the Off the road stage). For that reason, the work psychologists organised training sessions to help them with the pedagogical and relational skills embedded in the role they were about to play (e.g. summary of the contents to be transmitted to the trainees; exploration of a mentor's role). Table III explains the organisation of this stage.

The On the box stage received a positive evaluation from the trainees (M = 4.13). One item stands out: the utility of the topics to learn and perform the job as ICT (M = 4.13). On the other hand, according to the mentors' opinion, the formal learning period should be extended after the 4 × 4 Training ends: they believe so given the variability in the control of the chemical operation, both in a regular production situation or in critical situations (e.g. during the start-up of the plant after an unexpected/unplanned break).

5.1.2 A experiential learning: off the road stage. Upon conclusion of the first stage, the trainees continued their training, this time on-the-job (check Table IV). A mentoring component was added at this stage. During this 10-month stage, the interns entered the real production context. They were distributed by different plants and this was the beginning of a more individual and adjusted path for each of them. Additionally, an official mentor was assigned to each intern. The mentor's role was to guide, teach, challenge, reflect and motivate the intern throughout this journey, as well as keeping his own willingness to learn from the interns. All the mentors attended a specific training about the main principles of the mentoring as a mutual learning process to guarantee they were aware of the challenges

	Components	Participants	Methods and purpose
Previous work analysis and preparation	Set-the-track	Panel and local operators 36 Internal trainers 10 Mentors	Documentary analysis and ergonomic work analysis, carried out by the research team (work psychologists) Definition and joint validation of the programme's needs, objectives and stages
Training room			
Stage 1 On the box (2 months)	Train-the-Trainer	36 Internal trainers	Preparatory session with the internal trainers Identification and selection of the contents to be passed on from internal trainers to trainees
	Train-the-Mentor	10 Mentors	5 preparatory sessions for the mentors, distributed throughout the stage Presentation and dissemination of the professional know-how based on a principle of mutual learning and bidirectional process

Table III.
Description of the on the box stage

	Components	Participants	Methods and purpose
On-the-job			
Stage 2 Off the road (10 months)	Train-the-Trainee	36 Internal trainers 10 Trainees	Welcome session Work sessions carried out by work psychologists that use mediation tools progressively applied as resources adjusted to the extent of the trainees' immersion in the field[2] Training sessions with the internal trainers (283h in class) 3 moments for theoretical evaluation, to assure the trainees are ready to move to the following stage
		10 Trainees 10 Mentors	Immersion of the trainees in the workplace (two control rooms and external manufacturing area) Assignment of a mentor to each trainee and establishment of the corresponding dyads

Table IV.
Description of the off the road stage

that come with this role. Although each intern was assigned an official mentor, it is worth mentioning that all Foremen played the mentor role because this job is performed continuously on rotating shifts. Consequently, the interns had the chance to meet and work with different working teams and different mentors/supervisors.

The trainees provide positive feedback about this stage (M = 4.45). They highlight, for instance, the mentor's availability throughout the learning process (M = 4.89), particularly the effort to teach and share the knowledge (M = 4.56) and the ability to give feedback in due time (M = 4.44). In turn, the mentors consider the integration and the adjustment of the trainees to the workplace was adequate (M = 3.87).

When asked about the role they have accepted, around 86 per cent of the mentors mentioned they felt their work was appreciated because they have actively joined the training programme. Circa 71 per cent acknowledged the existence of situations where they have learnt from the trainees.

5.1.3 4 × 4 Training challenge. The Off the road stage had one additional moment. Towards the end of the programme, the trainees were asked to accept a challenge. The challenge consisted in the preparation of intervention proposals to improve the working conditions at the company (e.g. improvement in the technical instruments and equipment and formulation of work procedures). The purpose of this challenge was the combination of the trainees' knowledge (gained in the training room and related to the on-the-job practice) with the mentors' knowledge, to meet the company's real needs (Table V). To pursuit the 4 × 4 challenge, the trainees gathered in small groups and counted on the help from the mentors and other employees, as the operators and the maintenance technicians. This was a

	Components	Participants	Methods and purpose
On-the-job			
Stage 2 Off the road (10 months)	4 × 4 Challenge	10 Trainees 10 Mentors	Specific moment to outline proposals for intervention Formalisation of intervention proposals previously discussed between trainees and mentors as well as in group

Table V.
Description of the component 4 × 4 training challenge (Off the road stage)

"collective reflexive activity" (Falzon and Mollo, 2009) after the action, not directly focusing on the production aspects, but on the development of (individual and collective) know-how and (material and cognitive) tools, bearing in mind the transformation of the conditions under which the work is performed.

The trainees evaluated the 4 × 4 challenge positively (M = 4.45). We underline that all these considered that a similar challenge should be kept as part of the programme in future editions.

The challenge turned out to be crucial for the acquisition and development of technical competencies (M = 4.06) and for the reinforcement of contents and competencies previously acquired during the On the box stage (M = 4.22).

From the mentor's point of view, the challenge had yet other advantages. It improved the trainee's capacity to seek the cooperation of more experienced workers to complete their tasks (M = 4.22), and it enhanced their ability to share spontaneously information and knowledge with the co-workers (M = 4.22).

As a result of the work developed during the 4 × 4 challenge, 24 intervention proposals were defined (Table VI), which, by the end, were presented and validated by different stakeholders.

Six months after the programme ended, four improvement proposals were already implemented, all of them related to interventions on industrial equipment, 14 were on-going situations and six were not implemented.

As far as the evaluation on the implementation of these suggestions is concerned, the trainees (86 per cent) consider the proposals had so far a positive or very positive impact on the company's manufacturing area.

Data indicate the mentors (60 per cent) consider that the trainees did actually gain the double expertise (regarding the operation in the panel and outside) and are now performing the new position as ICT. The improvement in the trainees' performance over time is also pointed out, and they seek for the support from mentors and team members to clarify doubts: 72 per cent of the mentors acknowledge they still play the mentor role. Similarly, the trainees (86 per cent) also consider the mentor function is still vital to this day for their learning and professional evolution.

Given this support network by mentors, the trainees (71 per cent) consider they perform their job with more confidence and safety.

Regarding the internal dynamic of the mentoring relationships, the collected data show relationships with bidirectional professional exchanges, where learning is in fact mutual – the mentors acknowledge they learn pretty much (57 per cent) or very much (14 per cent) with their trainees, because of the latter's academic background and previous professional experiences. Another piece of information that stresses the learning bidirectional feature is related to the trainees' evaluation on the support they provide to other colleagues: the trainees (86 per cent) acknowledge they are increasingly consulted by other colleagues to help solving problems.

Table VI. Status of the intervention proposals per category, by the time of the follow-up evaluation

Categorisation of the intervention proposals	The proposals' implementation status		
	Implemented	On-going	Not implemented
Interventions on industrial equipment (14)	4	6	4
Equipment's procedures and mapping (6)	0	6	0
Safety systems (3)	0	2	1
Equipment maintenance (1)	0	0	1

Finally, the trainees highlight the intergenerational cooperation encouraged by the programme. In addition to the privileged relationship with the mentor, the youngsters underline the action from the remaining senior workers, both because they provide support and motivation and the possibility to get in touch with different ways of doing.

6. Discussion and implications

6.1 The transmission as an activity that is thought and defined together

In line with previous studies (Delgoulet *et al.*, 2012a, 2012b; Thébault *et al.*, 2014; Naweed and Ambrosetti, 2015), the professional transmission is a process that cannot be prescribed regardless of the work activity and of the characteristics of its context. In the 4 × 4 Training in particular, starting from the initial preparation stages, the work psychologists explored not only the specificity and the complexity of the chemical production context, but also the demands encompassed in the development of a new, and rather more flexible, job (combining the competencies of an outside operator and a control room operator). Then, they have defined a training framework together with the protagonists on the field based on the knowledge, constructed either individually or collectively. Though carried out at an early stage, the effects of this work revealed themselves fundamental, because they enabled the creation of a welcoming environment for the trainees' learning. Giving a significant contribution to reduce the distance between mentor and mentee (Nan *et al.*, 2013), such environment was to a large extent built because of the contributions from the senior workers. Because of their active involvement ever since the programme was launched and because of their familiarity regarding the programme's objectives, the senior workers did not consider the trainees as real threats to their jobs. This vision, translated into an environment to protect the youngsters, was noticeable during the transmission moments at the workplace (Off the road) and, in particular, in the 4 × 4 challenge component.

With this degree of understanding, it is possible to privilege a joint perspective of the professional competencies and the transmission needs. In fact, by the moment the programme's impact was evaluated, the aforementioned characteristics were positively assessed by the workers, particularly the adjustment of the programme to the company's reality and the involvement of different actors in the programme's preparation and implementation.

6.2 The transmission process through and during the work

By analysing the work activity at stake, it is assumed that from a methodological perspective the work at the chemical operation, with its unique organisation, is a resource for the transmission. However, in addition to being a resource, the work activity also emerges as a vehicle for the transmission. In line with findings from other studies regarding the situational nature of the learning process from inexperienced workers (Billett, 2000; Paloniemi, 2006; Cloutier *et al.*, 2012; Thébault *et al.*, 2014), the 4 × 4 Training relied on the transmission of know-how during and through everyday work activity. The trainees – when in contact with the chemical operation, integrated in different work teams, getting in touch with different players and supervised by the mentors – had the opportunity to cooperate in solving problems, clarify doubts or make decisions. The performance of the activity is, for that reason, a mediation element for the learning process; hence, the course of action in real context determines the contents addressed between mentor and trainee.

However, assuming such option, where the transmission is "inseparable from the work process" (Cloutier, 2011, p. 25), implies the acknowledgment that the learning process is under the influence of the same constraints that cross the work on a daily basis, whether they are production-related or about the organisation of the teams.

Apart from the mediation offered by the characteristics of the work situations, Delgoulet and Vidal-Gomel (2015) indicate two other mediation types during the construction of competencies by the youngsters, one more obvious, related to the mentor/trainer, and the other, sometimes invisible to the organisation, related to the work group (Vidal-Gomel, 2017). This means the junior workers do not develop their competencies exclusively by performing a task; senior workers shall be present to share their know-how and support the younger ones while they work. In this matter, it is widely recognised, both by the trainees and by the mentors, how important the collective dimension is; it actually defined the transmission in several moments. In particular, the mentors highlight the role played by their teams, and the opportunity to contact with the other production teams, in supporting the knowledge transmission during the Off the road stage. In this regard, previous studies (Filliettaz, 2011; Cloutier *et al.*, 2012; Thébault *et al.*, 2012, 2014) had already pointed out the importance of the work teams during the transmission processes. When the work teams embrace younger members, they are assuring a long-lasting renewal of the "professional milieu" (Gaudart, 2016), connecting the past (a time when the knowledge was developed in group and transmitted through the succession of generations) and the future.

The transmission during the performance of the work does not limit to the Off the road learning period, because six months after the end of the 4 × 4 Training, the trainees report they continue to ask for guidance and assistance from the mentors. This type of support from the mentor to the former trainee is quite often invisible and, for that reason, little attention is paid to the conditions under which it is developed. Still, even though assuming greater autonomy levels, the context complexity keeps challenging the less experienced workers on a daily basis, who then seek for support in the mentoring relationship previously established. Well, Filliettaz *et al.* (2015) call this type of support provided by the mentors "interactional participatory configurations", which represent a resource the least experienced use to face the complexity of the work situation. These participatory configurations relate to the invisible and less explicit forms of orientation and guidance provided by a mentor (as opposed to the instruction-based orientation forms, clearly visible), for example, the situations when the guidance corresponds to the professional practice in itself.

6.3 The transmission as a mutual learning relationship

Considering the learning dynamic within the mentoring relationship, 4 × 4 Training shows that it is not a unidirectional relationship; on the contrary, a two-way learning path is developed between mentor and trainee, both involved in a co-construction learning process.

The relationship between mentor and trainee results in advantages for both parties, that is, not only has the younger worker the opportunity to acquire new competencies, but also the more experienced worker develops his/her know-how. Wittorski (1996) states that when the mentors explain the work to the mentees (which involves the explanation of the procedures, the demonstration of the most appropriate actions and error correction) they are developing a new way of looking at themselves, at their own practices and action capabilities. Following this line of thought, it will lead to the development of "meta-competencies" (Wittorski, 1996) by the mentors, in other words, capacities to look and analyse their own competencies and means of action.

In turn, the trainees do not develop imminently productive competencies alone. Even though invisible to the formal mechanisms of coding competencies, the value of the knowledge transmitted between the senior worker and the trainee extends to the domain of the "know-how of caution" (Cru and Dejours, 1983), covering aspects about prevention and health protection. Such knowledge is useful to guarantee health and safety at work,

particularly relevant in complex industrial contexts such as the chemical sector, but also to assure production and quality (Cloutier, 2011).

6.4 Transmission-friendly organisational conditions

The results achieved with 4 × 4 Training are also possible because of a set of conditions assumed by the company from the start. To begin with, we underline the company's desire that the process to integrate the trainees should rely on the exploitation of the know-how held by the senior workers, recognising and valuing the experiential knowledge in the chemical production. On the other hand, the company allocated time for learning (12 months) and resources to support the process (including as a resource the consultancy for the programme's design and implementation), which conveyed a high degree of visibility and intentionality to the training situation. Consequently, the transmission was actually organised by the company, so the room for arbitrariness that so often leaves a mark on the process to integrate newbies is narrowed (Gaudart and Thébault, 2012). In addition, it is worth mentioning the possibility to define and implement training moments specifically conceived for the mentors (Train-the-Mentor). Contrary to the normative discourse that predicts a certain "natural" or "innate" capacity of the older worker to guide a younger one, 4 × 4 Training established moments to work with the mentors in advance to present and debate the transmission as a bidirectional process.

Finally, it is noticeable the importance of clearly stating the objectives at stake, the clarification of the transmission needs and the formalisation of a plan and a schedule for the training, procedural options that may have contributed for the definition of a work environment that favours that all the workers develop competencies.

Globally, given the increasing awareness about the so called "aging organisations" (Burmeister and Deller, 2016), our results achieved with the first edition of the 4 × 4 Training provide a set of clues for managers and practitioners for the development of similar transmission programmes, particularly in risky industries, where the health and safety issues are extremely important. Therefore, it is believed that the training programmes for younger workers shall focus their attention on the health dimension, lending interest on how mentoring may, on the one hand, assist the transmission and co-construction of protection strategies and, on the other hand, define possibilities for an intervention in context to improve the working conditions.

The aspects hereby discussed are important to systematise a few ideas regarding the implications for practice and for society of this training programme.

The outcomes of the project's impact evaluation and the fact that the company continued to implement the methodology in future editions (the project became an internal process), indicate that the training programme fulfilled its purposes. In addition, it may also provide strong leads, as previously mentioned, to managers and practitioners interested in the development and implementation of transmission programmes.

Concerning the society-related implications, three aspects stand out:

(1) the programme saw the advantage of the experience and know-how within each worker and, consequently, gave a different role to senior workers, hence fostering the intergenerational transmission of know-how;

(2) the integration of the young population in the labour market (after the training stage the company hired all the trainees); and

(3) the methodology, as it included a reflexive activity (4 × 4 Challenge) aiming at defining proposals to improve the working and safety conditions in an industry

considered dangerous, gave rise to a set of interventions that caused a positive impact on the production areas.

7. Conclusions

The singularity of the company's productive reality ended up questioning and shaping the training framework of the 4 × 4 Training. First, this is a chemical context characterised by emergent demographic challenges, which bring into the agenda of the company's leaders two major concerns. On the one hand, the possible paths to keep the experiential knowledge, despite the eminent retirement of the older workers and, on the other hand, a training mechanism wide and elastic enough to resist the complexity of the activity in the chemical operation, whose occupational health and safety issues take several dimensions (industrial, environmental and community). Given all these matters taken together, the methodological and synergistic structure of the 4 × 4 Training focused on the use of three different training strategies. The first one in class, where the theoretical knowledge about the chemical operation was addressed; the second one on-the-job (mentoring binomials), where the know-how was applied in action; and the third one in extended debate with the group (consubstantiated in the 4 × 4 Challenge). This was a reflexive moment after the action to build new knowledge between workers from different levels of professional experience. It is also worth mentioning that the research findings imply that understanding the organisation's conditions and their key players in an early stage are vital when planning and developing an intergenerational transmission programme.

Nevertheless, the 4 × 4 Training proposal reveals certain aspects that deserve attention to be improved. First, together with the HR leaders, the increase of work caused by the transmission device shall be kept under redoubled surveillance, particularly regarding the internal trainers or the mentors, who, simultaneously, have to meet the demands of their daily functions and ensure the training for the younger workers. Second, the On the box stage shall be reanalysed, because according to the trainees this training stage is not only dense, but also concentrated in time. Hereupon, we anticipate the possibility to intercalate the On the box training moments with the learning moments on the field with the mentors.

Notes

1. Work psychologists, authors of this manuscript. As consultants, our role in the project included the design, follow-up and evaluation of the training programme. For that reason, we adopted the attitude of action researchers, inside the action research community (Coghlan, 2011).
2. Some examples of such tools relate to the "logbook" or the "problem-situations" (whose purpose is to foster debate between mentors about their role with the newbies in critical scenarios, either regarding health and safety level, work organisation or quality), both used during the On the box stage.

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