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A METHODOLOGY FOR THE ASSESSMENT OF EXPERIENTIAL LEARNING LEAN: THE LEAN EXPERIENCE FACTORY CASE STUDY

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Abstract

Purpose - The purpose of this paper is to present a methodology to assess the experiential learning processes of learning lean in an innovative learning environment: the lean model factories.

Design/methodology/approach - A literature review on learning and lean management literatures was carried out to design the methodology. Then, a case study methodology was used to test the framework.

Findings - The methodology permitted to asses learning processes and course contents of educational dynamics carried out in model factories and to theoretically ground such learning processes. The test showed that learning lean management is supported through a complete coverage of the eight phases of the learning path.

Research limitations/implications - The methodology contributes to the literatures of lean management and experiential learning, proposing a methodology of assessment. Part of the framework could also be applied to other disciplines.

Practical implications - The methodology could be used for two purposes: to design training courses or to assess existing experiential learning courses.

Originality/value - Due to its intrinsic complexity, learning literature presents few practical framework or tools. Among them, none have provided practical and theoretical-based advice on how to use experiential learning precepts to teach lean management.

Introduction

The purpose of this paper is to present a framework to assess the experiential learning processes of learning lean in an innovative learning environment: the lean model factories. The framework could be used to design training courses or to assess existing experiential learning courses. The question guiding this research is: How is it possible to assess an experiential learning process?

The framework is specifically developed for learning lean in an innovative learning environment: the lean model factories, but it can be extended for other topics thought in a “learning by doing” modality. We agree with Abele et al. (2010) when they state that hands-on experience in a realistic shop floor environment is the most suitable way for interiorizing lean concepts.

The article is structured as follows. Paragraph 2 reports the literature background that highlights the literature gap. Paragraph 3 shows the research methodology adopted to develop and test the methodology. In Paragraph 4, we propose the methodology of assessment of lean experiential learning, based on two phases − coverage analysis and experiential analysis − and related tools − Learning Contents Covering Scheme and Learning Process Analysis Matrix. Paragraph 5 reports the case study of the Lean Experience Factory (LEF) of Pordenone (Italy). Finally, discussion and conclusions are drawn.

Theoretical background

Learning can be defined as “the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience” (Kolb, 1984). In other words, learning comes through experience.

Researches on learning define it as a change in the individual person due to the interaction between the subject and his/her environment. This interaction tries to satisfy an individual’s need and allows him/her to adapt more adequately to the external environment (Burton, 1963 in Hilgard and Bower, 1981).

According to Schunk (2012), learning has three main properties: it involves change, it endures over time and it takes place through experience. According to Dale (1946, 1969), in his cone of experience, the most effective learning process is the one that is able to provide as many as possible links to practical and concrete experiences. It is worth reporting that people generally remember only 10 per cent of what they read, 20 per cent of what they hear, 30 per cent of what they see, 50 per cent of what they see and hear, 70 per cent of what they say and write and over 90 per cent of what they do (Dale, 1946, 1969).

This happens also while learning operations management. Abele and Eichhorn (2008) show that learning is enhanced in specific environments such as “model factories”, where learners have concrete experiences during the learning process. “Hands-on-experience in a realistic shop floor environment are the basis of successful knowledge transfer” (Abele et al., 2010); in fact, the recall rate after three months of experiential learning about operations management content is 65 per cent compared to hearing (during lectures: round 10 per cent) or seeing (during seminars: round 32 per cent) (Abele et al., 2010).

A model factory is a locus for learning that reproduces a real operative small-size firm environment, both structurally and socially. This factory offers a neutral space where learners can make experiences, try, fail, learn from their own mistakes and finally improve (Kart Factory, 2010). It conveys the experiential learning principles by reproducing a simulated reality that stimulates learners’ cognition by challenging them to achieve abstract concepts through a direct and concrete practical application.

Specifically, lean model factories are focused on educating[1] learners (managers, chief executive officers, frontline and agents) about lean management contents. The majority of the works on experiential learning tried to demonstrate the effectiveness of experiential learning, especially for developing human resources competences (e.g. Kolb et al., 1986), but few propose a methodology to assess it grounded on experiential learning theory, especially in the case of management competences. Finally, a study on model factories –also due to the recentness of the theme – has not been realized yet.

Methodology

The present work is meant to help widen the knowledge basis on experiential learning and lean management and propose a methodology for evaluation based on experiential learning literature. It aims to understand how to evaluate lean management education done with experiential learning processes. This paper attempts to answer to the following research questions:

> RQ1. How is it possible to assess an experiential learning process?
>
> RQ2. How is it possible to measure the consistency of the learning content (lean learning) and learning process?

Company selection

The case refers to the LEF, which is an Italian management company born from collaboration between Manufacturers' Association of Pordenone (Italy) and the global consulting firm McKinsey & Company. The motivations for this choice are manifold.

According to Yin (2003) and Siggelkow (2007), reasons for the LEF case study selection are:

- Fit: LEF is strongly related to research aims. It is a unique example in the Italian landscape of experiential learning practices through a model factory to teach lean management. It has a peculiar learning place for educating managers through experiential learning principles. It is characterized by a real productive process. In fact, it defines itself as a "real factory": the learning place, where participants are trained and a real productive environment is shown where a real process and a real product (a compressor) are realized.
- Distinctiveness: It is a medium-sized company, but a case of success in terms of education methodologies, and especially in terms of lean and consulting capabilities. While its competitors use simple simulated processes and classroom games to teach lean, LEF considers them only as a basis to help people learn, and it continuously tries to offer to a wide experiential learning process through a simulated real factory environment. Learning comes through hands-on, first person, application of concepts.
- Revelatory nature: The company made it possible to directly observe the learning activities, and to participate in internal meetings of the faculty staff.

Therefore, we expected the results of the test to mirror the attitude of the company regarding experiential learning.

Research methodology

The research methodology includes an analysis of literature on experiential learning and of literature on lean management, from whence the theoretical proposal of the methodology was born.

This analysis of the literature highlighted the limited body of knowledge on the theme and its novelty. Because there has been limited previous research on the themes connected to implementation, they must still be explored deeply, considering also the complex system of variables that characterize the observed phenomenon (McCutcheon and Meredith, 1993; Handfield and Melnyk, 1998; Yin, 2003). This approach matches the goal of the study by focusing on a phenomenon with a dynamic and process nature and in which unfolding events play an important role in building explanations (Yin, 2003).

The case study design is opportune for presenting a relevant overview of the relevance and applicability of the methodology. The single case study is particularly appropriate for completely new and explorative investigations. The object of the case study is the test of the proposed methodology. As described by Yin (2003), the case study research design can be used to describe an intervention and its context. Some authors refer to this as a "field experiment". In the test in this study, the intervention is the application of the proposed methodology, and the context is the company studied.

Therefore, the case study process has been divided into two main steps:

1. Gathering the data using a structured exploratory study: The investigation of the company studied (and especially the model factory).
2. Testing the proposed method: The methodology has been tested within the context of a company to verify its operative feasibility.

The case study and testing activities were conducted by:

- Face-to-face interviews with key informants: model factory designers, instructional designers, trainers, professors, consultants and learners to gain multiple perspectives.
- Observations of the training activities and courses.

Finally, the application of the operative tools of the framework was carried out by an heterogeneous team of four experts (a University research fellow, a trainer, a McKinsey's advisor and a PhD candidate from LEF). The research team considered the different learning phases and assessed the lack of the learning activities.

A proposal of a methodology for evaluating lean experiential learning

The methodology (Figure 1) grounds on learning literature and lean management literature, in particular a learning model labeled eight-phase learning path and on the lean management model. We propose to assess both process and content, and to assess them contemporaneously. The methodology is based on two main phases:

1. The coverage analysis, which assesses only the content.
2. The experiential analysis, which assesses the content and the process.

Each of these two phases is operatively supported by a tool.

In particular:

1. The coverage analysis measures if the content of the course has been covered and at which level/percentage. This phase is supported by a tool called the Learning Contents Covering Scheme (Figure 2): it shows, in a visual manner, the coverage degree (level) for a lean training course in terms of contents with reference to the amount of lean items mapped within the proposed lean management model. For each block of the model, lean principles and techniques taught are listed and the coverage percentages can be reported in a box at the bottom of each block.
2. The experiential analysis measures not only the content but also the process. It allows analyzing each formative module in relation to the proposed model for learning. It is supported by a tool, the Learning Process Analysis Matrix: each phase of the process can be marked if accomplished, if partially accomplished or if not accomplished with that experiential learning process phase (Table I).

Specifically, for content and process, the following section develops the proposed methodology and operative tools and details the content and the process.

Content: lean management

Lean is conceived as "an integrated socio–technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability" (Shah and Ward, 2007). Lean production uses less of all: less effort, less space, less investments and less time for new products development (Womack et al., 1990). In addition, to-be lean:

> […] requires a way of thinking that focuses on making the product flow through value-adding processes without interruption (one-piece flow), a pull system that cascades back from customer demand by replenishing only what the next operation takes away at short intervals, and a culture in which everyone is striving continuously to improve (Liker, 2004).

The lean management model firstly grounds on the works of Sakakibara et al. (2001, 1997) and De Toni et al. (1994, 2013). These authors group lean tools, techniques and principles into three levels: just-in-time (JIT), support functions and value stream mapping (VSM).

Each level is then subdivided into lean building blocks. The JIT level groups practices related to the productive flow that have the main objective of continuously reducing each kind of muda (waste) up to the elimination (Shah and Ward, 2003). JIT is subdivided into three building blocks:

1. Planning and control: Principles and techniques grouped into the planning and control block aim at synchronizing production and market demand (Panizzolo, 1998). These goals can be attained through leveled production, the use of small lots, pull control of flows, and so on (Panizzolo, 1998).
2. Process and equipment: The production processes should be able to ensure mix regularity and uniformity over time. These conditions require, for example, shortening of set up times, the use of cellular layouts and of mixed model lines, process capability, availability and reliability of machines, the use of "error proof" equipment, and so on (Panizzolo, 1998). Such practices are grouped into the second lean building block of JIT: process and equipment.
3. Supplier–customer relationships: It ensures a supply chain vision, grouping lean principles and techniques for creating solid and trustworthy relationships, upstream with suppliers, involving them during the activities of product development and quality management; and downstream with customers, basing on the skills of the sales network, realizing the exchange of information and analysis of customers' needs to focus on product development and production.

To sustain the JIT level, a second-level support functions is necessary. This level is subdivided into:

- Product design: Practices related to the product development block aim at improving manufacturing and assembling processes. They play an important role in supporting advanced production methods (Panizzolo, 1998).
- Human resource management (HRM): The HRM block groups all the principles linked to people development, training and employee involvement and commitment to support JIT practices (Panizzolo, 1998).
- Quality management: Respect for workers can be conceptualized as the glue that holds the other lean production dimensions together (de Treville and Antonakis, 2006). Quality management block groups practices aiming at sustaining processes and products of great quality. Among them, Shah and Ward (2003) include techniques of process capacity measurement.
- Maintenance management (or total productive maintenance): The maintenance management or total productive maintenance block includes lean practices designed to maximize equipment effectiveness such as planned predictive and preventive maintenance of the equipment and maintenance optimization techniques (Shah and Ward, 2003).

Performance improvements are connected to firm competitive advantage (De Toni et al., 1994; Sakakibara et al., 2001, 1997). To maintain this advantage, the whole lean system has to be "held in running" by the consciousness that supports the philosophy of continuous improvement. We conceptualized the continuous improvement as a lean block that acts as a feedback loop (De Toni et al., 1994).

To fill up the building blocks of lean management model, we mapped from the literature a total of 102 items related to lean. A total of 32 contributes (26 papers and 6 books) about lean were reviewed. Items were then grouped and ordered according to their definition. We split lean items on lean techniques and methods and lean principles and characteristics, ranking them considering the number of citations in literature.

Process: learning path

A comparison of the main experiential learning models, which see learning as a cyclic or helical path (Quaglino, 1985), is shown in Table I. The comparison of these nine models leads to an identification of four macro-phases of experiential learning, reported in the last column of Table I:

Concrete experience: A tangible experience of a real event.

Reflective observation: An analysis of the experienced event.

Abstract conceptualization: A conceptual synthesis of the analysis.

Experimentation: A practical application of what has been conceptualized.

Concrete experience.

The learning path starts from a cognitive discovery made by the learner. He observes a mismatch between the real situation that is being experienced and an ideal situation. This gap originates a cognitive dissonance between what Moon (2004) calls internal experience (cognitive individual interior representation) and external experience (objective reality). From this realization, or mere discovery, the learning process begins as a process of searching for a gap resolution. The learner will "struggle" to fill that "real–ideal" gap.

Concrete experience is composed of two sub-phases: introductive briefing and as-is state exploration:

1. Introductive briefing: Entering the learning process from the concrete experience, a learner has to carry out an act of problem setting of reality (Dewey, 1938). During this act, the learner must use his own cognitive matrix defined as the amount of prior experiences, a sort of experiences baggage (Moon, 2004). He uses it to analyze the experiencing situation. The learner focuses on the aspects of the situation that he subjectively considers more relevant. The introduction (briefing) aims at making explicit this act of focalization and drives learner's attention to the situation aspects that are linked to and relevant for the didactical objectives of the training module carried out. In synthesis, a "frame of reference" (Moon, 2004) is given to learners. The first learning macro-phase aims also to instill a doubt, that is, according to Engeström and Sannino (2010): questioning prior learners' opinions and ways of thinking.During this first learning step, didactical objectives have to be set up. Learners conduct a "reflection for action" (Cowan, 1998). They become aware of actions that they are going to perform within the learning circle. Ideas and purposes drive the whole process of learning (investigation). As a principle of adult learning theory, learning is triggered by the

overall results that learners are willing to achieve. Ideas are continually revised on the basis of feedbacks collected during the testing phase of each round of the learning cycle.

2. As-is state exploration: After having shared learning objectives between faculty and learners, the process goes on with a concrete diagnosis of the situation as-is state. This first state can be considered a Deweyian messy situation. During this phase, learners focus on imperfections, problems and inefficiencies of the situation. During explorative actions, learners perform an act of “reflection in action” (Cowan, 1998; Schön, 1983). They must be aware of actions that they are carrying out.

Reflective observation.

During the second learning macro-phase, each learner performs a reflective analysis on the past concrete experience:

- Sharing: Learners relive the precedent experience. They mentally reprocess activities carried out with the aim of sharing them in a logical way with the faculty and other learners. The main distinctive features of the as-is state are exposed, debated and discussed.
- Re-elaboration: A key learning activity is the re-elaboration of what has been experienced. A reflective activity on actions, stand over by a faculty member, is done. The trainer captures insights provided during the sharing phase and, in this way, leads learners to the abstract conceptualization phase, in a motivated way. Learners analyze collected data, observed procedures and implications of such data. The overall learning process done so far is revised (Moon, 2004).

Abstract conceptualization.

What has been observed in the earlier stages is conceptualized here. Learners develop, individually or in groups, abstract concepts through prior concrete experiences, lessons and guidelines received. At this stage, they receive external input to be probed later in the subsequent phase of experimentation:

- Theoretical concepts transfer, explanation: In a hetero-directed learning process (formative), the trainer explains or recalls, entering details of the problem, concepts that allow the resolution of the as-is state. It is important that the trainer acts as a coach, inviting learners to reflect and to build themselves concepts and theories on which ground solution proceeds.
- To-be state planning: Learners apply in a theoretical way concepts and contents explained to problems detected in the as-is state. They design solutions to be tested in the next learning phase.

Experimentation.

Testing phase consists of the practical implementation of the designed solution and in the final review of the entire learning process. The analogy, for a lean transformation process, consists of the practical application of lean principles and methods under study to the future state (to-be state) of the model factory:

- To-be state application: The solution proposed during the to-be state planning phase is verified “in the field” and allows learners to bring the as-is situation to a final “to-be” situation. Here, learners can implement their own solution and make a comparison with other proposed solutions (generally lean solution proposed by the faculty).
- Consolidation: The learning cycle finally ends with an overall reflection on what has been done through the learning path (Engeström and Sannino, 2010; Cowan, 1998). If the problem is not completely solved, learners can retrace the learning cycle again, identifying new problems to the final situation obtained. This becomes the new initial situation (new as-is state) for a second learning cycle. On the other hand, if experimentation leads to a functional solution, learners enter the consolidation phase. During this last phase, concepts are consolidated and learners acquire competences. At this stage, learners have also transpose and drop learned contents to their own daily working experiences.

The test of the methodology: LEF case study

The methodology has been tested to the formative modules supplied by the LEF of Pordenone (Italy). At LEF, a lean transformation is simulated through a productive process reconfiguration, passing from a departmental configuration (as-is state) to an optimized cellular layout (to-be state). LEF delivers different catalogued courses spanning from 1 to 22 days, content-focused courses from 1 to 3 days and courses on contract.

The case study allows to understand the learning processes, through the application of the operative tools of the framework, and to test inductively from the field the learning model deducted from the literature.

Content and process: lean management learning path in LEF

In this section, we describe the application of the eight phases of the learning process (process) to lean management (content) in LEF highlighting content and process.

Concrete experience

Introductive briefing

- Process: Almost all the training modules at LEF start by an introductive briefing during which learners share their prior “experiences baggage” (Moon, 2004) and “reflect for action” (Cowan, 1998). They prepare their mindset for going through the learning cycle. They set learning objectives, also reporting real concrete working-life situations, and build the first “emerging” concepts of the contents they are going to learn. Most of the time, learners are “exposed” and moved into their “uncomfortable zone”.During this phase, LEF’s staff operates in two ways, depending on the contents’ (the training module) difficulty and on learners’ perceived capabilities. The higher the difficulty and the lower the capabilities, the more the trainers present carefully the concepts and detail the procedures; on the contrary, they skip the introductive step to rapidly go to the explorative phases.

- Content: The waste analysis (Technique 1), for example, consists of a brief introduction on the muda (waste) concept and on the seven Ohno's (1988) seven waste typologies. A physical distribution of templates follows. These templates will be used during the exploring phase. Possible LEF's weakness points in this step are linked to the duration of the phase that is strictly bundled to the kind of learners (how many explanations they need to catch the concept).

As-is state exploration

- Process: Participants go on with a concrete diagnosis of the as-is state of the LEF's manufacturing process. During this phase, learners focus on imperfections, problems and inefficiencies of the process, collecting them, sometimes helped by physical templates given by faculty. During this phase, learners work in team. During this phase, learners concretely move through the factory carrying out a diagnosis of the main issues related to the productive process.
- Content: In this step, for example, participants do not have to recognize the kind of activities: VA or not value adding (VA) or not value adding (NVA) (Technique 2). This could be an LEF's weak point. During this learning phase, a lack can be related to the absence of team working and immediate feedback from the trainers.

Reflective observation

Sharing

- Process: Learners relive the precedent experience. They mentally reprocess activities carried out, coached by trainers, and share a logical resume of what they experienced. In LEF, these phases are considered relevant. Significant time is spent to help learners conceptualize and abstract the problems of the as-is state of the factory.

Re-elaboration

- Process: A peer review of learners' feelings and workforce's behaviors of the manufacturing environment is shared. This is in accordance with Moon's 2004 phase of reviewing feelings and the emotional state. Learners, coached by trainers, make a comparison on what experienced both in terms of collected data and emotional feed-backing of the experience. Possible learning lacks have to be connected to the absence of the discussion phase because of limited learners' involvement or short time.

Abstract conceptualization

Theoretical concepts transfer, explanation

- Process: Learners develop abstract generalizations of what they experienced. In this phase, LEF's faculty generalizes lean concepts and explains principles, tools and methods for solving the as-is state inefficiencies and ineffectiveness. The trainer explains mistakes carried out by learners during the explorative phase and introduces the concepts for an optimal planning of the future state of the factory. Explanation is the learning method that permits a transfer of many concepts in short time. However, as Dale (1946, 1969) observed, people remember only 20 per cent of what they hear. Sometimes, as in LEF, the explanation phase is used as a link among subsequent learning paths. It gives learners some concepts that are not immediately needed, but will be necessary in the following training modules.In terms of lean transformation, the conceptualization allows learners to implement principles and methods of lean production, starting from inefficiencies noticed in the as-is state, for planning the future situation (to-be state).

- Content: For example, during the set-up activity of a workstation through the single-minute exchange of dies (SMED) technique (8), the trainer explains mistakes done by the operator involved in the tool changeover with the help of a film, registered during the concrete experience phase.

Learners carry out an active qualitative/quantitative analysis of the improvements of the changeover process. Learners' suggested improvements are applied to the to-be state of the workstation. For example, for the SMED technique, the operator redoes the changeover. In this case, the cycle time of the operation are measured to put into effective performance improvements achieved.

To-be state planning

- Process: Learners apply in a theoretical way concepts and contents collected during the explanation. Working in a team, they search for solution to the issues of the manufacturing process.
- Content: For example, they reconfigure the plant layout, and write standardized procedures for some working activities of the process.

Experimentation

To-be state application

- Process: Participants implement the planned activities to the to-be state of the model factory. LEF proposes two possibilities: the first is the effective implementation of the planned activity by learners (e.g. standard operating procedures [SOPs]), while the second is a "diagnosis" of the solution predisposed by LEF's faculty in the to-be state configuration of the model factory (e.g. line balancing). Some training module do not need the experimentation phase because they cover contents related only to the as-is state diagnosis (e.g. waste analysis and VA−NVA analysis). Sometimes, due to time, this phase is not carried out, and learning module ends with a final discussion. In other cases, the improvements are shown by the faculty in the configuration of the to-be state of the model factory.
- Content: For example, for the techniques 5S and SOPs, the learners themselves operate firsthand the transformation with greater results in terms of learning. Learners design and concretely implement the standardization of an activity subsequently tested by an operator. In these phases, the improvements gained through the timing and the disposability of the workstations to effectively show the taught techniques and accompany the learning process.

Consolidation

- Process: This step ends the learning path with an overall reflection on what has been done (Engeström and Sannino, 2010; Cowan, 1998). Concepts are consolidated, and learners acquire competences. At this stage, learners also transpose, coached by faculty's members, and learned contents to their own daily working experiences.Each learning process finally ends up with a general revision of the learning path traveled by learners aimed at transposing the learned contents to the operative realities of participants' companies.
- Content: If the problem is not completely solved, that is, the training module or the learning contents are just part of a larger subject, learners can enter a subsequent learning (e.g. waste analysis, VA−NVA analysis and time charting are parts of the VSM activities). Once learners achieved concepts such as waste, value-added activities, time measurement, etc., they could enter the learning path of the VSM that is building a map of value, recognizing the sequence of operations, the sources of waste, etc.

Coverage analysis at LEF

Figure 3 shows the application of the second tool, the Learning Contents Covering Scheme to the lean week. In each block of the lean management model are summarized the lean techniques and principles taught. Each block shows the coverage percentage calculated, dividing the total number of lean items taught and the total number of lean items mapped from the literature. Here, it is possible to see that the course does not cover the product development and customer–supplier relationships items. HRM was covered by the 45 per cent, quality management by 31 per cent, maintenance management by 17 per cent and planning and control by 36 per cent. Instead, the lean blocks of process and equipment (69 per cent), value analysis and mapping (67 per cent) and continuous improvement (50 per cent) received a deep coverage. This fact confirms that the focus of the LEF is the change of mentality and aptitudes of the course participants.

Experiential analysis at LEF

The Learning Process Analysis Matrix can be applied with reference to both training modules and lean techniques. Table II reports the analysis of the lean techniques taught during the lean week course. According to the visual thinking principle, accomplished learning phases were signed with "•"; partially accomplished learning phases were signed with "◑", while phases that were not accomplished at all were signed with "○". In parallel, the presence of weakness points in the training course was also outlined by the research team. Thus, after the assessment, training modules were improved to reach better levels (Table III).

This analysis shows how it is possible to assess the experiential learning course. Considering Knowles' adults learning principles exposed in the introductive chapter, LEF's faculty recognizes that adults are relevancy- and goal-oriented and provides during the briefing step of the learning process clear explanations of learning objectives and operative usage for concepts. This operative declination of learning content can also be seen in the eighth step (consolidation) of the learning path. Here, participants transpose what they have learned to their work reality. Learners are also autonomous and self-directed. Thus, during the learning process, they should be left free to "learn by trying". This occurs during the learning phases of as-is state exploration and to-be state planning. Participants try to diagnose LEF's manufacturing plant problems using concepts and tools gained from the first phase of the learning cycle and of course, deriving from the precedent learning paths coverage. For example, regarding the assessment activities of the Ohno's (1988) seven wastes, participants move around the LEF's plant trying to recognize waste. Their learning activity is "monitored", and they are coached by the LEF's staff during the whole learning path. Thus, they received feedbacks immediately.

The faculty tries also, when possible, to recall learners' own baggage of prior life experiences and knowledge to support learning activities. Many learning cycles in LEF start by asking learners' opinion and prior knowledge about an argument, asking them to report daily and concrete examples from their working life.

The considerations highlighted by the analysis have promoted the improvement of educational processes with particular reference to both experiential phases of the learning process and complementary need of theory and practice. Revision activities, where needed, were introduced in the LEF courses training. The analysis shows that the LEF, in fact, shows performance improvements gained from the introduction of lean principles and techniques. In fact, regarding the simulated process, learners can assess the following improvements:

- 100 per cent increasing of hourly productivity per employee;
- 90 per cent decreasing of production lead time;
- 80 per cent reduction of work in progress within the productive process flow; and
- 33 per cent decreasing of the space used by the process equipment.

Discussion

The proposed methodology permits to verify the appropriateness of the learning processes of LEF according to the models derived from the literature. The test highlights that the methodology is feasible from an operative point of view because of its simplicity and effectiveness. The analysis confirms how LEF's learning processes follow the path and how LEF was able to assess and revise "learning process lacks", according to the assessment results.

The framework (models plus tools) has implications both academics and managers. From the point of view of the literature, this work has highlighted the missing links between experiential learning and lean and between experiential learning and model factories; on this basis, the authors have proposed a methodology that bridges this gap based on a content analysis and a content–process analysis.

From a research point of view, the work contributes in suggesting that experiential learning can be assessed in a systematic way, by means of a methodology and specific tools. Following Kolb, "the watchers favour reflective observation, while the doers favour active experimentation". In designing courses for "doers", it is important to have in mind how the course can be effectively designed, in a way to have an improved learning experience, i.e. "perceiving new information through experiencing the concrete, tangible, felt qualities of the world, relying on our senses and immersing ourselves in concrete reality".

In terms of lean, the real situation is represented by the as-is state or initial configuration of the process simulated within the model factory. This state has to depict what the Dewey (2009) would define a “problematic situation”. That is, a situation able to highlight the lack of efficiency and effectiveness of the organization/productive system. Inefficiencies have to be focused and linked to the conceptual material of learning (training modules). The as-is state problems and their exposition by the faculty staff have to be finetuned on learners’ capabilities, without being trivial or impossible. Learners have to move forward into their Vygotskyian Zone of Proximal Development (Vygotsky, 1978). In terms of lean transformation, conceptualization allows learners to implement principles and methods of lean production, starting from inefficiencies noticed on the as-is state, for planning the future situation (to-be state).

From a practitioner’s point of view, the framework can be used as an “assessment tool” to test the coherence between the learning model and the effectiveness of the learning processes carried out in the firm/school assessed: in other words, how well the learning process takes place according to experiential learning point of view. Moreover, the lean management model permits to gain a rapid view of the amount of contents delivered by the company with reference to the main lean items present in the literature.

Both the operative tools of the framework permit a schematic visualization of points of strength and weakness. Based on this diagnosis, the task of the faculty will be to evaluate how to effect a revision from the point of view of both trainers and learners.

From a dynamic perspective, then, the operative tools can be used as a tool to verify the alignment between the learning path and the learning processes of the company. Repeating the analysis with a periodic frequency, the model factory can come to redesign the learning path, to carry it out in many possible ways entering the path from different point and carrying over different learning journeys according to didactical objectives, learners and contents.

Finally, the models could be used as a tool for instructional design, in other words, to lead a design and planning of learning activities and contents. Moreover, because of its nature, the learning model can also be applied also to other fields than lean education.

Conclusions

The present study allowed for building a solid theoretical ground for the learning and training processes that occur in the model factories. A methodology for assessing learning lean by means of experience has been developed from the literature analysis. It will allow trainers to oversee each step of the “learning tour” with more focus.

However, the study has some weaknesses. The main one is the fact that the methodology is based on experts’ judgments. To overcome this weakness, it will be necessary to widen the panel of experts and diversify them as much as possible. Moreover, the research can be based on a wider database, including other courses of the same model factory or to test it into other companies.

Finally, we collected many different sparks both from the literature and from learners' feedbacks that suggest that experiential learning and in particular the model factories yield to a deeper learning effectiveness due to the direct contact between a learner and a real, also familiar, learning place. A fact that has held steady in our mind was the statement of a learner at the end of a course: "you changed the way I saw the factory".

Such kind of learning paths vouches for an efficient education that merges theoretical concepts with immediate practical applications. The statement that with its simplicity synthesizes the overall research related to learning by concrete experiencing is from Dewey (2009):

> "An ounce of experience is better than a ton of theory simply because it is only in experience that any theory has vital and verifiable significance. An experience, a very humble experience, is capable of generating and carrying out an amount of theory (or intellectual content), but a theory apart from an experience cannot be definitely grasped even as theory. It tends to-become a mere verbal formula, a set of catchwords used to render thinking, or genuine theorizing, unnecessary and impossible."

Note

Notice that we always use the term education instead of teaching because educating, from Latin etymology, means draw (duce) out (e) that is helping people to learn, whereas teaching deriving from Latin insignere means impress.

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