

# **E-learning strategy to improve user adoption in a PLM context: insights and recommendations through the SharePLM case study**

**Master's Thesis submitted for the Master of Science HES in  
Information Sciences**

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**Geneva, 17 August 2020**

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Geneva, 17<sup>th</sup> August 2020

Léna Nyffenegger

# Acknowledgments

I would like to thank all the persons who agreed to give me their precious time, for interviews and for answering the survey or simply by giving me valuable advice. And in particular:

Eliane Blumer for guiding me through all this work and providing me with valuable advice. For your availability and your contagious enthusiasm. I am extremely grateful for your support and presence throughout this project.

Beatriz Gonzalez and Helena Gutierrez for agreeing to do this work with me, for your kindness and all the time you dedicated to me.

Myriam Jenni who helped me during the whole master thesis' lifecycle, from brainstorming the subject to submitting this paper. Thanks for your patience, your catchy advice and for facing the PLM universe with me through rain and shine.

Mathilde Panes for accepting the position of expert for the defense of this thesis.

Juliette Cevey for motivating me every day like a coach, making me laugh and giving me confidence.

Karin and Bernard who always supported me and brought the food and coffee I needed to achieve this work. Jonas, for illuminating the path with just the right amount of ugly.

Toni who reviewed this work, supported me from the beginning and knew how to shake me up.

Myriam D., for spreading love and happiness around you. For your encouragements during the Bachelor's and Master's degrees and for all the good energy you brought us. May you rest in peace.

## Abstract

Product lifecycle management is challenging and its scope is very broad. Companies want to be able to accelerate product development to reduce time to market. The use of PLM logics helps transform market opportunities into competitive advantages. PLM tools enable control, reliability, better management and ultimately optimization of data and processes.

But the historical complexity of PLM, developed by engineers for engineers, makes the use of its tools just as difficult and complex. In this context, e-learning appears to be an ideal solution to train employees, allowing regular content updates to provide training adapted to the many changes occurring in the PLM-universe.

Despite the huge sums invested in e-learning, ROI is often hard to measure, its actual use and impact difficult to quantify. The introduction of new PLM technologies is complex and employees can show resistance to these changes, which can also be reflected in the use of e-learning. An incorrect use of PLM solutions can increase data problems, making the software an invalid source of information.

In this research, we tried to identify and understand the factors influencing e-learning user adoption in order to be able to integrate these elements into an effective adoption strategy. To that end, we first conducted a literature review on topics inherent to PLM and e-learning at work. Then, data were gathered through a series of semi-structured interviews with experts and an online survey. Finally, we compared these results with the theoretical elements identified earlier.

As a result of this work, we have been able to formulate various recommendations, as well as creating tools, to help improve e-learning user adoption in a PLM context. In particular, we have highlighted the importance of taking into account factors related to technology but also and above all specific individual issues.

**Key words:** e-learning - workplace training – training transfer – adult learning – PLM – Product Lifecycle Management – user adoption – e-learning adoption

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# 1. Introduction

This thesis was written for the purpose of the Master of Science in Information Sciences given at the Haute école de gestion in Geneva, and made collaborating with SharePLM.

SharePLM is a consulting company based in Spain that has been helping companies connect products, people and processes for over 10 years. They specialized in developing PLM learning strategies to improve users' adoption of the software. In an effort of continuous improvement, SharePLM is interested in new ways to deliver better services to their clients. Oftentimes, companies overlook the importance of the use and adoption of their services or products once delivered.

Through this work, we tried to help SharePLM in designing a better digital learner experience by investigating and understanding e-learning practices and user adoption through literature and other companies' practices. The aim of this study was to define a global e-learning strategy to improve user adoption in a PLM context and to develop an online course for the firm.

## 1.1 Context

Product lifecycle management (PLM) is a framework that helps companies manage their product information and follow business processes through a product's full lifecycle. The real challenge is to get the right information to the right people at the right time.

Effective PLM isn't just about choosing the right technology; it is about connecting all the information pieces in a meaningful way, through the lifecycle process, so that the data flows smoothly.

Nowadays, most product-manufacturing companies have realized the importance of using such strategy and technology to remain competitive in an ever-changing global marketplace. However, to truly reap the benefits of PLM, companies must not only embrace and implement it, but they also need to ensure that all their employees are informed and trained properly on the matter. This aspect is usually overlooked, PLM initiatives are perceived as being technological projects, and the attention given to change management is minimal.

As one of SharePLM consultants once said: «the best tool or process is only as good as the person using it».

## 1.2 Research objectives

The main objective of this work was to identify and understand the factors affecting e-learning adoption and to determine what strategic elements SharePLM can put in place in order to increase user adoption in a PLM context.

The specific objectives to achieve this were first of all to understand the specificities of PLM and e-learning in a professional context. Then, to collect data conducting interviews with specialists and creating an online survey. Next, to analyse the answers and the data and compare them with the literature's findings. Finally, to formulate recommendations and thoughts on the subject and create deliverables for SharePLM's work.

## **1.3 Methodology of the research**

### **1.3.1 Literature review**

This first theoretical part examines the specificities and concepts related to PLM and e-learning through the literature. To do this, we collected information found in the literature: by searching for articles in specific databases, in professional and scientific literature, but also in books, and on specialized and reliable blogs and websites.

### **1.3.2 Data collection**

In the second practical part, we collected data to better understand practices in different companies, whether or not using PLM tools. First through an online survey that we developed and sent by email to companies specialized in PLM and distributed more widely on LinkedIn and in specific PLM groups.

Then we gathered data through interviews conducted with 3 specialists from different fields in order to benefit from their experience and expertise. So, research and reflection were carried out on e-learning in companies and more specifically on the barriers and elements facilitating the adoption of e-courses by employees.

### **1.3.3 Deliverables**

In the third part, we created different deliverables for SharePLM: an article for their blog, a course to inform SharePLM's clients on the different concepts and theories of this work and a post-course survey in order to help them improve their future e-courses.

## 2. Product Lifecycle Management (PLM)

In this research project, we will delve deeper into the use and impact of e-learning in enterprise, specifically into its application in the context of teaching Product Lifecycle Management. In this first part, we take a closer look at PLM to understand its complexity and specificities.

The late 1970s saw the introduction of the first personal computers, followed in the middle of 1980s by the revolution of computer-aided design and computer-aided manufacturing (CAD/CAM). In 1985, the premises of PLM were laid down with product data management (PDM) when the car manufacturer American Motors Corporation was looking for a way to be more competitive by developing its products more quickly. The company's engineers became more productive through the use of computer-aided design (CAD) softwares. The introduction of a common database enabled the centralization of drawings, documents and essential information to product design and communication between the various stakeholders (ArcherGrey 2020).

Today, in a globalized world where changes are rapid, large and small product-manufacturing companies must face many challenges, whether it be innovation, risk management or technological or legal adaptations. To stay competitive and to be able to respond and quickly adapt, companies must access and leverage data, information and knowledge throughout the entire product lifecycle.

### 2.1 Definition

The complexity of PLM makes it hard to agree on a single definition. We have decided to use the definition proposed by Corallo *et al.* (2013) who have reviewed in their paper different definitions of PLM, both in an industrial and an academic context:

*« (...) PLM Product lifecycle management – is a strategic business approach that supports all the phases of product lifecycle, from concept to disposal, providing a unique and timed product data source. Integrating people, processes, and technologies and assuring information consistency, traceability, and long-term archiving, PLM enables organizations to collaborate within and across the extended enterprise. »*

The industries likely to use PLM are numerous and varied. The main sectors using PLM solutions, as resumed in Figure 1. The automotive industry, industrial equipment, aerospace and defense and high technology industries represented over 77.6% of the global market in 2019. Emerging industries, such as engineering & construction, healthcare & lifesciences or consumer packaged goods & retail are also growing and gaining market shares (Quadrant Knowledge Solutions 2019).

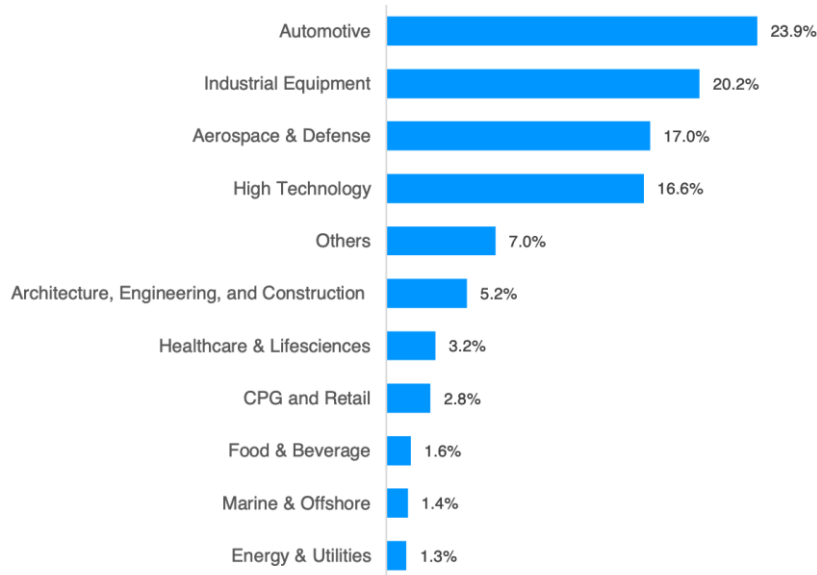


Figure 1: Revenue share by industry verticals (Quadrant Knowledge Solutions 2019)

## 2.2 The purpose of PLM

There is a strategic dimension behind PLM. Indeed, a good management of the industrial products' lifecycle can allow a company to gain competitive advantages in a fast-paced environment: by reducing design costs, improving product quality, reducing time to market for a new product or speeding up innovation (CCI Alpes De-Haute-Provence 2016).

In addition, PLM solutions connect the different disciplines and allow companies working with large teams, suppliers and partners geographically dispersed to collaborate through smart products (Quadrant Knowledge Solutions 2019).

The use of a PLM strategy and the resulting tools, among other things, allows companies to meet the many challenges they face, in particular:

- Continuous innovation;
- Global collaboration;
- Risk management in complex projects;
- Rapid technological changes;
- Product customization and traceability;
- Growing competition;
- Shorter product development and delivery times;
- Globalization;
- Tighter regulations and legislation (Corallo *et al.* 2013).

Table 1 summarizes the many benefits brought by the use of PLM.

Table 1: PLM benefits (adapted from Corallo *et al.* 2013)



## 2.3 Product lifecycle phases

The product lifecycle refers to the different stages that the product will go through from its design to its launch on the market until its withdrawal. Marketing and management decisions are made based on the costs, opportunities and risks specific to each stage. Every product generates a great amount of data and information that will be produced and used by various partners (designer, engineers, manager, customers, suppliers, etc.) during the whole cycle.

In the literature, the number of stages generally ranges from 4 to 6 (or more), from conceptualization to design, build, market, support, maintain and retirement (Quadrant Knowledge Solutions 2019). The main phases being (Hargrave 2019):

1. The product development that consists of the market analysis, conception, design and the product testing;
2. The market introduction that encompasses the initial release of the product;
3. During the growth phase the sales revenue increase year-over-year;
4. In the maturity stage the product hits the upper limits of its demand cycle;
5. Decline/stability phase occurs when a product has achieved or reached its point of highest demand. At this stage, demand remains stable or declines slowly since a newer product makes it outdated.

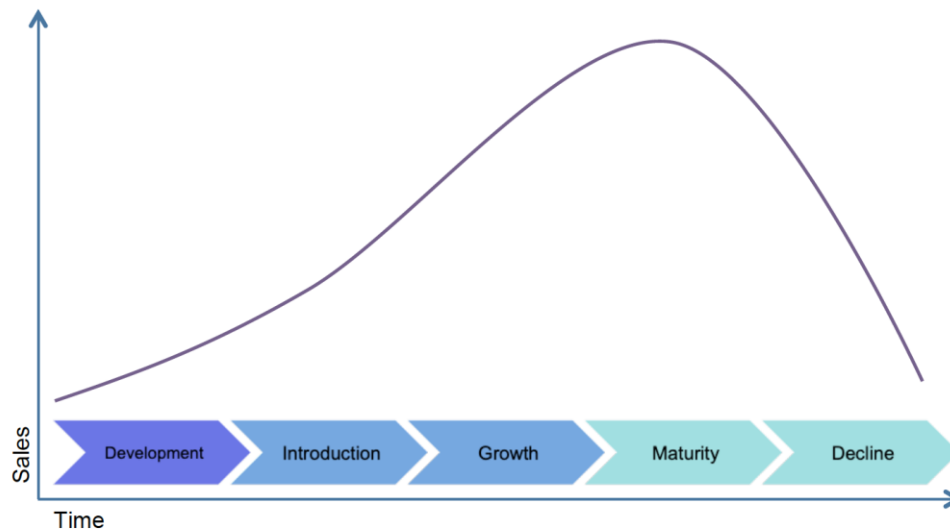


Figure 2 : Product lifecycle main phases (adapted from Hargrave 2019)

## 2.4 PLM market

The global product lifecycle management market size, including revenue data from PLM solution suppliers, systems integrators, and resellers in the PLM space, was valued at USD 47.8 billion in 2019 and is expected to expand over USD 60 billion by 2023 (Markets Insider 2020).

This market is constantly growing, thanks to a particularly ever increasing demand for PLM solutions for small and medium enterprises in various sectors. The main motivation of these companies is to optimize the manufacturing cost of their products. A market also stimulated by the digital transformation of certain industries and the widespread use of Industrial Internet of Things devices (Grand View Research 2020).

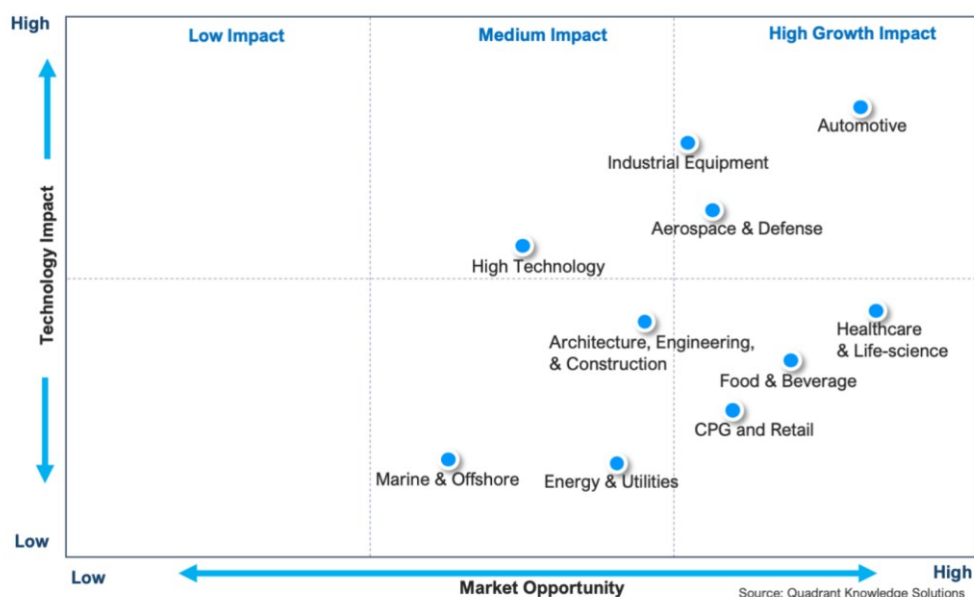


Figure 3: "Market Opportunities and Technology Impact Analysis by Industry Verticals" (Quadrant Knowledge Solutions 2019)

In the global market, automotive, industrial equipment, aerospace and defense and high technology are the main users of PLM (Figure 3). Leading PLM solution providers include Dassault Systèmes, PTC, Siemens, SAP (Figure 4). These companies develop and market PLM technology that enables product-manufacturing companies to manage complex processes associated with complex documents, products, projects and systems. They reach a wide variety of PLM use cases by offering complete technology solutions for innovation, design, product data management, simulation and digital manufacturing (Quadrant Knowledge Solutions 2019).

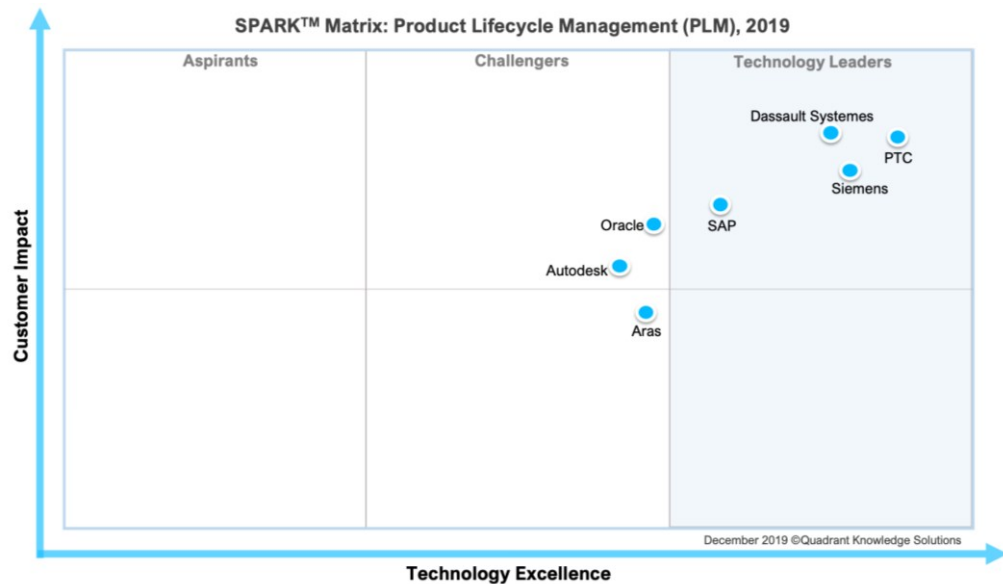


Figure 4: Strategic Performance Assessment and Ranking Product Lifecycle Management (PLM) Market (Quadrant Knowledge Solutions 2019)

## 2.5 PLM softwares

PLM softwares support companies to centralize the various data and information needed to build and manage products throughout their lifecycle. It is a system and a global approach that impacts and mobilizes people, processes, organization and applications of the information system (Debaecker 2013). PLM solutions enable companies to manage processes related to documents, products, projects and systems while meeting the specific needs of each industry and user (Lascom 2020).

*«A holistic PLM solution supports enterprise-wide requirements for engineering designs and development, manufacturing workflows, and managing consistent product information. The solution enables collaboration amongst various stakeholders, both internal and external, responsible for specific product lifecycle processes.»* (Quadrant Knowledge Solutions 2019)

The market share of cloud-based PLM applications has been growing continuously for several years and is expected to represent 30% of the total PLM solutions market by 2024, a market of more than USD 4.16 billion, according to a study conducted by Quadrant Knowledge Solutions (2019).

PLM solutions generally contain the following parameters (from Quadrant Knowledge Solutions 2019):



- Multi-CAD solution: multiple applications to produce, manage and distribute data fundamental for designing, analysing and simulation of an industrial product. Several tools exist including computer-aided design (CAD), computer-aided manufacturing (CAM) or electronic design automation (EDA).
- Product Data Management (PDM) platform: allows the management of products, processes, data and information through a single central system. This information can contain various documentation, models, information on requirements and manufactured parts, notes or multi-CAD data. In order to meet business needs and stimulate innovation through collaboration, teams have secure access to data according to their role. A PDM platform can form the basis and be extended to a more complete PLM platform.
- Digital Manufacturing solution: «includes integrated application suites to support the transition of product design into manufacturing processes. It enables organizations to perform advanced modelling, simulation and analysis of the manufacturing processes and plant environments including layout, equipment, resources, assembly lines, material flow, and such others. It helps manufacturing planning engineers to validate process design and optimize operational performance.» (Quadrant Knowledge Solutions 2019)

As we have learned, PLM is an essential element for the company to be able to meet its challenges. Its usefulness is undeniable as Autodesk (2020) reminds us:

*«Product lifecycle management (PLM) is the process of managing complex product information, engineering and manufacturing workflows, and collaboration. PLM software connects people, processes, and data across the entire product lifecycle to a central repository of information. So everyone from the conceptual designer to the end-customer is on the same page, sharing the same up-to-date product definition.»*

### 3. E-learning

In our analysis, when talking about e-learning, we consider all forms of electronic learning, whether microlearning, webinars or smart learning for example, on all existing devices (desktop computer, mobile phone, smart devices (phone, tablet, computer). We have used the definition of e-learning which characterizes it as «instructional content or learning experiences delivered or enabled by electronic technology» (Becker *et al.* 2013).

The history of e-learning is relatively short, but it is characterized by important changes and rapid evolution, not in the learning process (there is little innovation in pedagogical practices), but in its technological development (Tynjälä, Häkkinen 2005). In this part, we intend to understand how to improve workplace learning.

#### 3.1 (E-) learning in a professional context

Learning at work differs from learning in an academic environment for example, in that learning at work is mainly informal and incidental (Tynjälä, Häkkinen 2005). This is because learning in a professional context is intended to solve problems and must be practical. The aim of e-learning in a working context is to:

- Train employees in the idea of development, lifelong learning, but also, in some cases, to comply with an imposed legal framework;
- Create value for the company, which must be able to benefit from the knowledge acquired by its employees during training programs, whether «by improving its functions, process, products or practices» (Tynjälä, Häkkinen 2005, p.320).

Technology has transformed the way we learn and has reinforced the collaborative aspect of learning, its ability to increase interaction between peers and group work. It has also made it easier to share information and spread the knowledge and expertise of members of the same community (Tynjälä, Häkkinen 2005).

E-learning is a solution which is particularly suitable for learning at work. Indeed, we often speak of *flexible delivery*, emphasizing that employees must be able to control, appropriate and customize their learning path, both for the place where the course is taken and for the course content itself. E-learning meets these requirements and is therefore a suitable solution (Tynjälä, Häkkinen 2005, p.320).

##### 3.1.1 Benefits of e-learning in the workplace

The most recurrent argument in favour of e-learning is its ability to offer customised training, adapted to the specific needs of each learner with «*just-in-time*» and «*just-for-me learning*» (Berge, Giles 2008).

Also mentioned is the possibility of quickly updating the content of e-learning courses to keep them up to date and current (Becker *et al.* 2013). Tynjälä and Häkkinen (2005) tell us about the fact that «technology has made it possible to create virtual environments that almost exactly mimic authentic ones». These two elements are particularly interesting in the context of PLM training courses, which must be regularly updated, among other things to integrate software improvements and new functionalities.

Despite the fact that cost effectiveness, access and flexibility are benefits demonstrated by several studies (Becker *et al.* 2013), other research have nuanced the contributions of e-learning courses compared to those made in a traditional way (face-to-face courses). In their article published in 2005, Derouin *et al.* made the following findings: «it is difficult to conclude that e-learning is more, less, or equally effective at the learning level than traditional classroom-based training. This dilemma is not unique to e-learning. Indeed, even in traditional forms of learning and development, many decisions within the development and implementation of the individual intervention will impact on its ultimate success or failure.»

### **3.1.2 Disadvantages of e-learning in the workplace**

E-learning carries a very impersonal image, and is often blamed for its lack of interaction. This disadvantage can isolate the learner but also act as a barrier to e-learning adoption (Bell 2007). The lack of face-to-face communication with the instructor, as well as with other students, could cause the learner to feel a lack of pressure. As a result, students are more likely to disengage from their studies. As we'll see in the *data collection* chapter, this characteristic emerged both in the online survey and in the interviews we conducted.

Another issue with e-learning is the lack of immediate and personalized feedback. In a traditional classroom, teachers can give students immediate face-to-face feedback. When a question arises, it can be solved on the spot. Furthermore, personalized feedback has a positive impact on students, as it makes their learning process much easier, engaging and significant. E-learning, on the other side, does not allow for this. Oftentimes, when a learner is stuck somewhere in the e-course, they will either abandon or forget about their question, which will remain unanswered and potentially impact the student's overall learning experience (Tamm 2019).

A common trend in e-learning education is to focus largely on developing theoretical knowledge, rather than practical skills. The reason for this is obvious; it is much easier to implement a theoretical course in an online environment than to create an interactive and practical e-course (Tamm 2019). Hence the importance of compensating for this by insisting on social presence, for example through feedback or by fostering interaction between learners.

### **3.1.3 Adult learning**

One of the characteristics of e-learning in the workplace is that the learners are adults. Hence, adult learning theories need to be considered when developing e-learning courses.

Adults learn in a different way from children or adolescents, and it is therefore not possible to transpose classical school pedagogical methods to adult pedagogy (Couchaere 2018). Many characteristics, such as age, experience, background, constraints and responsibilities are elements to be taken into consideration.

Moreover, studies have shown that adults who are confronted with a conventional educational system show resistance. They believe that training should provide them with concrete results that can be applied to their work, used in their career development or for their personal fulfillment. Thus, training in a professional context is not limited to the transmission of knowledge, but also contributes to «understanding in a conscious manner» (Couchaere 2018).

According to Tynjälä and Häkkinen (2005, p.321): «In sum, adult learning, at its best, is based on – or at least utilises – learners' experience, involves the learner in a reflective process and in social processes, is problem-oriented, aims to benefit both personal development and organisational learning processes, and is organised in flexible ways.»

#### **3.1.4 Social nature of (e-) learning: (virtual) communities of practice**

The theory of communities of practice, formalized by Wenger in 1998 as part of socio-cultural theories, describes the process of knowledge construction as a social process and emphasizes the role of community in learning (Brown *et al.*, 1989, Wenger, 1998). We all naturally and informally belong to communities of practice, through groups of individuals interacting and working together, whether at work, at school, at home or in leisure activities.

Common values will be formed in these groups, shared practices will emerge, and a common identity will be built through interaction, exchange and communication between peers (Tynjälä, Häkkinen 2005). The role of such groups in the workplace represents an opportunity to form common work practices and values, but also to exchange knowledge, stimulate innovation and encourage mediation. In the study published in 1994, Nonaka also emphasizes the importance of sharing individual knowledge among colleagues as a necessary condition for the organizational learning process.

*«In order to transform individual learning processes into organisational processes, organisations need both recognition of the significance of sharing knowledge and opportunities for individuals to share their experiences.» (Lehesvirta 2004)*

To be consistent with Lehesvirta's definition of learning in the workplace, courses and tools available to employees should be adapted to reflect this vision. E-learning platforms, in addition to providing support materials and encouraging individual self-training, should also encourage and enable employees to share their ideas, transmit their knowledge and present their intuitions using specific tools (Tynjälä, Häkkinen 2005).

E-learning platforms should also make it possible to store this knowledge and these ideas and make them accessible to employees at all time. «In this way, e-learning environments could serve simultaneously as a tool of organisational memory. Some theorists of the learning organisation explicitly refer to the potential of information technology for sharing knowledge and developing mutual understanding.» (Tynjälä, Häkkinen 2005)

### **3.2 Transfer of training**

Today, e-learning is an integral part of continuing education in many companies and its success is still growing. However, companies are still little inclined to evaluate the quality and effectiveness of their online training. Huge sums of money are spent on e-learning every year, so it is important to demonstrate that training investments are having an impact and that the training is actually used in employees' work and tasks.

Learning implies a change, more or less permanent, in the learner's capacities, acquiring new knowledge, new skills, different behaviours and attitudes. Transfer of training refers to the fact that learners apply in a concrete way in their work, these new abilities (skills, knowledge, attitudes...) seen during the training (Curry 1994). It is the main indicator of whether the training has produced results. In his study, Curry (1994) points out three possible outcomes: positive transfer occurs when the learning results in better job

performance, negative transfer takes place when the learning brings worse job performance and zero transfer happens when the training leads to no effect on the work performance.

Different factors influence this transfer of knowledge, several models exist to understand and evaluate the transfer, some of which are presented below.

### 3.2.1 Training transfer models

Baldwin and Ford's model (1988) (figure 5), shows the importance of input elements, such as trainee characteristics (skill and motivation level, life experiences, attitudes and values, ability to learn and apply knowledge...), training design (training content, principles of learning, sequencing of training activities...) and work environment (degree of support, opportunity to use, feedback...) and also the importance of output elements such as learning and retention as well as generalization (application of knowledge) and maintenance (continuity to use new methods) (Baldwin and Ford 1988).

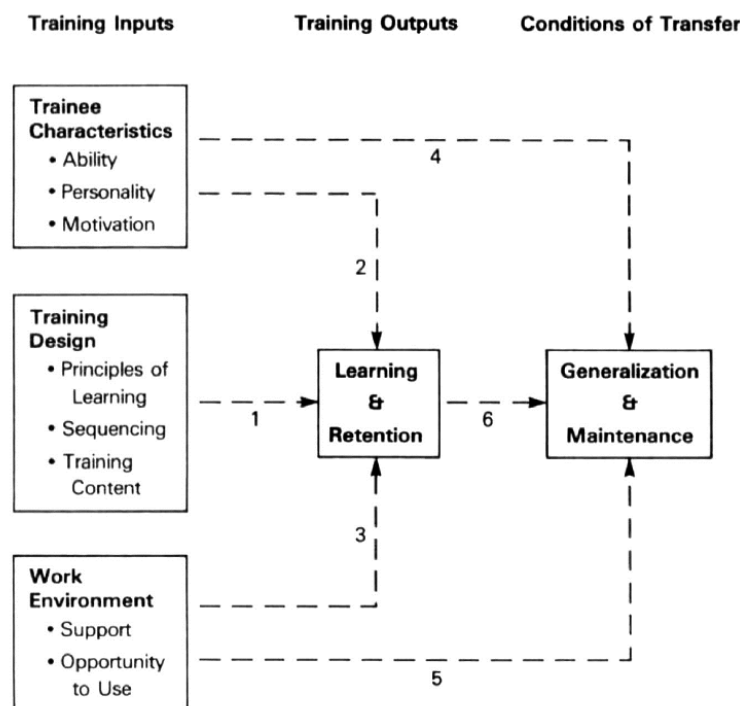


Figure 5: A model of transfer process (Baldwin and Ford 1988)

The most widely recognized and validated model is the Learning Transfer System Inventory (LTSI) developed by Holton *et al.* (1998, 2000) to examine the specific factors that influence the transfer process. This model includes 16 factors that facilitate or hinder transfer, divided into 3 categories (motivation, personal capacity, work environment).

Kirkpatrick (1975) also developed a well-known and recognized model with 4 phases for evaluating training effectiveness: reactions, learning, behaviour and outcomes (Kirkpatrick 1975).

A more recent model, the Evaluation of Training Transfer Model (ETF), adapted from the LTSI, aims to identify the factors that affect e-learning and training in Spanish companies (Pineda-Herrero *et al.* 2011). The model presents 8 factors classified in 4 categories, as showed in table 2. It is immediately apparent that the factors associated with individuals are the most numerous. Several researches indeed show the significance of «the role of social

processes in transforming individual learning into organisational learning» (Tynjälä, Häkkinen 2005, p.320).

Table 2: ETF model (Pineda-Herrero *et al.* 2011)

Factors related to the participant	Factor related to the workplace	Factor related to the organization	Factor related to the training program
<b>Satisfaction :</b> the effect that the level of participant satisfaction has on learning transfer	<b>Opportunity to transfer :</b> the opportunities presented to the participants to apply learning and the resources they dispose of to do so	<b>Organizational support :</b> the wide variety of policies and actions a company implements in order to facilitate learning transfer	<b>Transfer design :</b> the degree to which the design of the courses enables and facilitates learning transfer as guidelines and indications given in order for the trainees
<b>Acquired learning :</b> the level of learning acquired which subsequently affects the degree of learning transfer			
<b>Motivation to transfer :</b> the desire, intensity and personal commitment to transfer the learning acquired in training to the work place			
<b>Self-efficacy :</b> the degree to which the participant feels confident of their success in applying learning			
<b>Accountability perceived :</b> the level of responsibility participants feel towards applying learning			

In an article published in 1994, Curry describes another method, the TOTAL approach (for Transfer of Training and Adult Learning), which analyzes the positive and negative factors affecting transfer, through the prism of the factors identified by Baldwin and Ford, before, after and during training. He refers to transfer forces: «Since transfer is affected by the action or inaction of certain individuals, their identification is a crucial step toward increasing transfer» (Curry 1994). These critical actors in the transfer process are learners, coworkers, managers etc. He adds that employees with good skills and high motivation are the most likely to be able to facilitate the transfer by coaching their peers (referring to them as «transfer coach» (Curry 1994). In another study, Merriam and Leahy (2005) talk about «peer coaching» and found that it «[...] turned out to be the most important influence on transfer of interpersonal skills [...]».

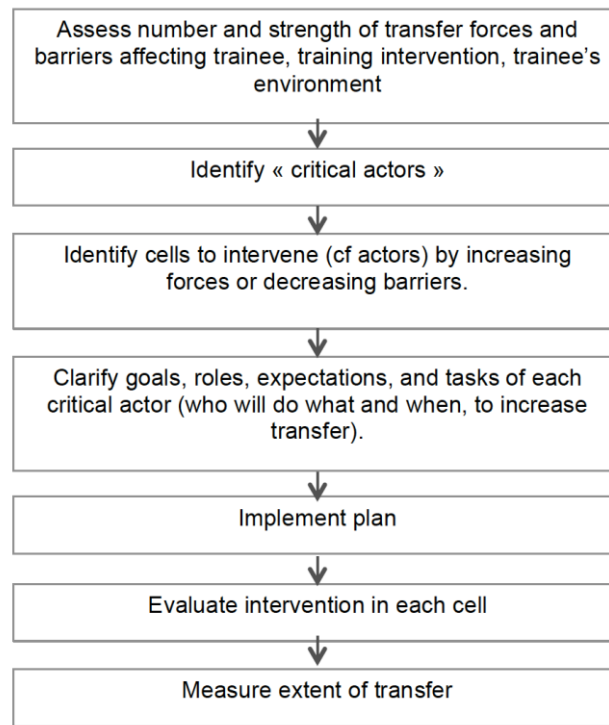


Figure 6: The TOTAL model, figure three (Curry 1994)

Although useful or even necessary to understand and act on the variables that affect the effectiveness of training, such approaches and instruments are nonetheless long and complex to put in place and costly for companies.

### 3.3 E-learning adoption

Cambridge dictionary defines adoption as «accepting or starting to use something new» but also as «choosing or taking something as your own». So there is the idea of owning something and using it regularly. We found it worthwhile to define e-learning adoption because of its many characteristics and as we consider it as a concept in this work. However, we did not find a definition of e-learning adoption (or learner engagement) in the literature or on the Internet.

We have therefore decided to define its main characteristics and propose a definition based on those of technology adoption (IGI Global 2020; Al Mustapha 2019), for which there are more definitions.

We separated the characteristics into three categories, according to whether they primarily concern the firm, whether they are of a rather individual nature or if they are global. Without being exhaustive and requiring further refinement, the table and the definition below summarize the essential elements related to e-learning adoption.

*Suggested definition: e-learning adoption refers to individual and organizational behaviours and processes that lead to accept and use e-learning in learning routines.*

Table 3: Suggested main characteristics of e-learning adoption

Individual characteristics	Organizational characteristics	General characteristics
<ul style="list-style-type: none"> <li>• How to attract and retain employees on online platforms;</li> <li>• Individual choice to use e-learning;</li> <li>• Individual behavior of accepting and using e-learning (and by extension taking e-courses).</li> </ul>	<ul style="list-style-type: none"> <li>• Organization's decision, to implement and use e-learning (programs and platform);</li> <li>• The successful implementation of learning technologies;</li> <li>• How to foster employees' engagement for obtaining better learning outcomes.</li> </ul>	<ul style="list-style-type: none"> <li>• How to boost the ease and access of online learning to users and organizations;</li> <li>• Processes that lead people and organizations to accept e-learning and integrate it into their learning routine;</li> <li>• When e-learning is approved in social practices.</li> </ul>

In order to engage employees in an e-learning activity, certain elements will be decisive, such as the quality of the courses, the time made available during work, the appearance and ease of use of the platform, the absence of computer bugs or the media on which users will be able to follow e-courses.

### 3.3.1 Technology acceptance

For a technology, or by extension an e-learning program, to be used, it must first be adopted. When we talk about learning and technology adoption, several theoretical models (technology acceptance models) that analyse the behaviours leading to adoption can be cited, for example (IGI Global 2020):

- TPB: theory of planned behaviour: this theory explores how individuals' norms, attitudes shape individual behaviours and intentions;
- TAM: technology acceptance model: this theory highlights the reasons why users accept and use a specific technology;
- UTAUT: unified theory of acceptance and use of technology: the purpose of the UTAUT is to explain users' intentions to use an information system and the resulting use behavior.

Another rather sociological model can also be cited, the technology adoption life cycle (figure 7). This model identifies 5 groups of users with a specific psychological and demographic profile and describes whether they are inclined or not to adopt and use a new technological product or innovation (Business-to-you 2020).

The first group consists of innovators, people who are interested, enthusiastic and comfortable with technological products. However, they represent only 2.5% of the population. This group can have a positive impact on other groups, as innovators have the ability to convince others.

Then there are the early adopters (visionaries). Less comfortable with technology, they are still enthusiastic and are looking for an innovative product as much as for its ability of improvement. These first two groups are important to convince, they are references for



others in the early market, but they represent a minority. A gap separates them from the last 3 groups.

Then come the early majority (pragmatists), capable of adapting to technology, they are interested in its practical side. They wait to see the results of other users before starting.

The late majority (conservatives) are almost as numerous, 34% of the population. They share the same characteristics as pragmatists, with the difference that they believe more in traditions than in progress. They prefer to wait until a new product or technology becomes a standard.

The last group consists of laggards (skeptics), the most reticent to new technologies. Very wary and reluctant to change, they are convinced that these new technologies will not keep their promises.

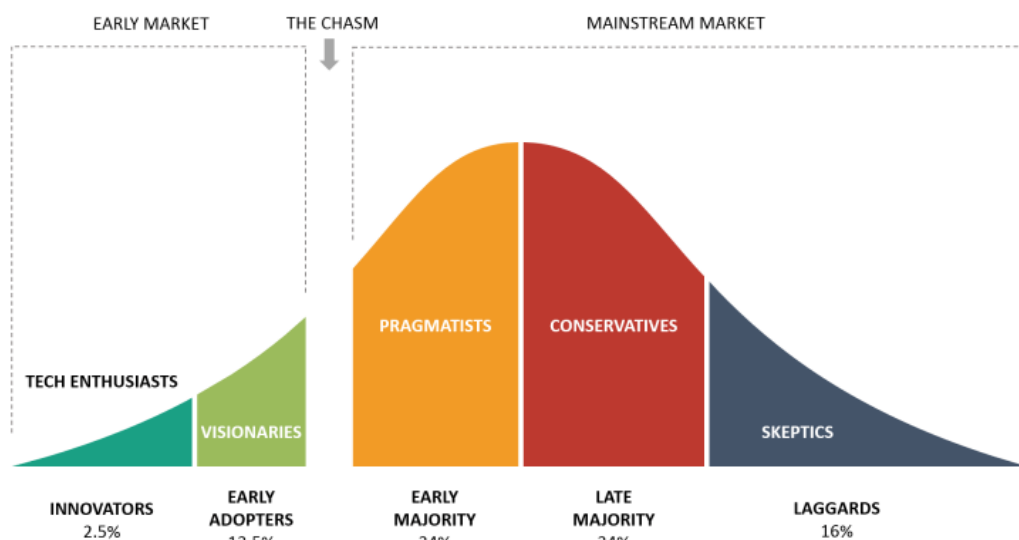


Figure 7: Technology adoption life cycle (Business-to-you 2020)

Groups on either side of the gap prefer to rely on the recommendations of groups on their own side. One solution is to convince segment after segment, starting with targeting users in the early majority.

This model was developed for the adoption of technology, but similar logics can be found with the adoption of e-learning. The idea is therefore to convince and meet the needs of the pragmatic majority. The proposed solution should thus enable them to improve their work.

### 3.3.2 Barriers to e-learning adoption

In a study published in 2013, Becker *et al.* identified 3 key elements that reflect barriers to e-learning from the individual learner point of view: «the nature of e-learning as a learning approach, technology adoption barriers and concerns about lack of time and potential interruptions when trying to complete e-learning».

*The nature of e-learning as a learning approach:* this first barrier refers to learners' concerns about the e-learning process itself, particularly its usefulness and relevance. But also to the potential lack of personalization of content and reduced interaction between users (Becker *et*

al. 2013). In another study published in 2014, Lee *et al.* talk about perceived usefulness (PU) defining it as «the degree to which a person believes that a particular system would enhance his or her job performance. Vankatesh *et al.* (2003) proved empirically that PU is positively associated with users' behavioral intention to use information systems.» They also define the concept of perceived ease of use (PEOU) which «refers to the degree to which a person believes that using a particular system would be free of effort. Previous studies indicate that PEOU positively influences user's behavioral intention.» (Lee *et al.* 2014)

*Technology adoption barriers:* These factors are related to the implementation and use of technology and the technical problems that this can cause, but also to the psychological barriers that may result. Examples include the lack of skills related to the technology and the stress related to the use of tools and technology in general.

The authors refer to previous studies on technology adoption to conduct their study. In particular, they use the D&M IS Success Model developed by DeLone and McLean (DeLone, McLean 2003), which introduces 6 factors to consider in order to guarantee the success of IS implementation: «system quality, information quality, use, user satisfaction, individual impact and organisational impact» (Becker *et al.* 2013). After reviewing their model, the authors added certain factors, including that «the level of support offered to users in the form of assurance, empathy and responsiveness can make a critical difference to the success of systems» (DeLone and McLean 2003 cited in Becker *et al.* 2013). And Becker *et al.* (2013) concluding: «This represents a move to recognise the importance of «people factors» and the role the role individuals may play in determining the ultimate success of IS adoption efforts.»

*Concerns about lack of time and potential interruptions when trying to complete e-learning:* when companies begin to offer online training, they often assume, mistakenly, that these new learning processes will be integrated into the daily routine of employees. This leads to concerns about workloads and available time during working hours (Becker *et al.* 2013).

The most significant or recurring barriers identified in previous literature and studies have been summarized by Becker *et al.* (2013) and presented in table 4 below. The 4 most significant barriers identified by Mulenberg and Berge (2005) were numbered in order of importance.

Table 4: Barriers to e-learning adoption (adapted from Becker *et al.* 2013)

Individual barriers	Barriers relating to the technology	Institutional barriers
<ul style="list-style-type: none"> <li>• Learner motivation (4);</li> <li>• Cultural resistance;</li> <li>• Ability to use technology (<i>universal factor</i>);</li> <li>• Attitudes to technology;</li> <li>• Workload concerns (<i>universal factor</i>).</li> </ul>	<ul style="list-style-type: none"> <li>• Poor ICT infrastructure;</li> <li>• Technical problems (<i>universal factor</i>);</li> <li>• Technology cost;</li> <li>• Difficulties with availability and access to computers or necessary devices (<i>universal factor</i>).</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of social interaction (<i>most significant barrier</i>)(1);</li> <li>• Organizational culture / resistance to change;</li> <li>• Lack of time and support (<i>universal factor</i>) (3);</li> <li>• Administrative and instructor issues (2);</li> <li>• Lack of incentives to use.</li> </ul>

### 3.3.3 Factors facilitating e-learning adoption

By identifying and understanding the impact of the different barriers affecting e-learning adoption, solutions can be found to successfully implement e-learning programs in organizations (Becker *et al* 2013).

Regarding the three main barriers identified by Becker *et al* (2013), the authors first suggested that the different concerns of learners must be taken into account in order for e-learning to be successful. They also added: «The critical issue is to reassure users about the nature of e-learning and to address concerns about the validity and usefulness of e-learning as well as provide opportunities to engage actively with the material, and potentially with other learners». This includes the availability of qualitative teaching materials and appropriate tools. Companies also need to pay particular attention to learner support and time allocation, both of which should be part of their e-learning adoption strategy (Becker *et al* 2013).

In terms of time and workload concerns, these barriers reinforce the importance of managers and HRD to ensure that employees have appropriate time and space, at their workplace or off-site, to use the available resources. These issues should also be addressed in the organization's strategy to encourage employees to use e-learning and enable the company to take full advantage of it (Becker *et al* 2013).

As for the factors influenced by technology, we can refer more generally to the barriers to IS adoption to find answers. Brzycki and Dudt (2005) highlighted the three most important factors in order to successfully manage these barriers: efficient change management, the creation of adequate support for learners, and providing incentives to motivate users and ensure adoption.

In their study, Tynjälä and Häkkinen (2005) talked about the importance of communities of practice. They pointed out that e-learning environments may also be useful in building new communities, bringing together learners with different roles, backgrounds and levels of expertise in order to encourage a diversity of perspectives and exchanges. This is yet another way of binding users together, always with the intention of increasing adoption. They also suggested different solutions summarized in table 5, related to course development but also to adult pedagogy, in order to increase the use of e-learning individually or more globally at the organizational level (Tynjälä and Häkkinen 2005):

Table 5 : Solutions to increase the use of e-learning (Tynjälä and Häkkinen 2005)

Course design	Pedagogical issues
<ul style="list-style-type: none"> <li>• Promote theoretical content that can be transposed into the daily work of learners;</li> <li>• Encourage reflective exercises;</li> <li>• Promote exercises oriented towards progressive problem solving;</li> <li>• Diversify course content and learning materials (reading, writing, discussing, using metaphors, audio, visual etc.).</li> </ul>	<ul style="list-style-type: none"> <li>• Support and encourage individual reflection and knowledge sharing among different groups;</li> <li>• Foster dialogue;</li> <li>• Provide structured support throughout the e-learning process;</li> <li>• Integrate face-to-face e-learning whenever possible.</li> </ul>

## 4. E-learning in a PLM context

PLM has historically been perceived as complex, sometimes not very intuitive and difficult to use. Indeed, at the beginning, the data management solutions that will later become PDM (and will be the foundation of PLM) were designed by engineers for engineers. In trying to make these solutions as accurate and perfect as possible, engineers created very complex solutions. Today, these solutions have evolved but have not become simpler, on the contrary. Furthermore, they have been extended to other professions than engineering, making it difficult for these new users to work with such solutions (Moore 2020). As Peter Bilello points out in an interview (MinervaPLM 2020): «PLM isn't an engineering discipline, it's a lifecycle discipline which means it's an enterprise discipline.»

We have listed below 3 PLM specific and unique elements that will be translated into software solutions, training resources and e-courses:

- The duration, as the product travels through a long life cycle. We talk about an holistic end-to-end view, that includes all the stages in the manufacturing of a product and therefore the total duration of this journey will be more important;
- The complexity of the product development itself that will go through many stages of development. This is a particularly complex process that requires the PLM solution to integrate every aspect and characteristics of the product's life cycle, from its design to its withdrawal from the market;
- The scope of the people involved in the processes. Many different departments and roles are involved: from the business department, to research and development, to sales, and quality management. Each sector has its own challenges, and work with specific tools and regulations that need to be supported by the PLM software.

### 4.1 PLM solutions

The initial investment when deploying a standard PLM solution is significant, both in terms of time and cost. It requires a lengthy implementation, licenses, complex upgrades, not to mention future maintenance. PLM providers offer standard (out-of-the-box) solutions that require extensive customization to meet business needs and industry-specific challenges.

PLM softwares sometimes offer very sophisticated and complex functionalities. The system involves many disciplines, data and features. Following customization, each company will end up with a particular PLM environment and specific functionalities.

#### 4.1.1 The cloud, a growing market

For a few years now, PLM solution providers have been trying to reach a new customer base, mainly SMEs, by targeting new markets with cloud-based solutions. Interest in these solutions is growing, especially in non-traditional sectors, allowing a democratization of PLM. Indeed, by opting for a solution in the cloud, companies are attracted by a great potential for evolution and benefit from a more attractive price than a traditional solution (with on-site implementation), as the monthly/annual cost is lower (Quadrant Knowledge Solutions 2019).

These different elements allow us to understand the usefulness and necessity of training employees in the correct use of these different tools and functionalities.

The purpose of e-learning in a PLM context is therefore to help users to perform their daily tasks, but also to enable and promote collaboration between different business lines. It also increases productivity and improves the quality of the data produced, making the software a reliable source of information (Jenni 2020).

## **4.2 Examples of e-learning for PLM**

There are a number of options available to companies wishing to train their employees in the use of PLM softwares. All of these solutions represent an additional cost for companies (no price is given in this work, as pricing depends on factors such as company size or requested functionalities).

When selling their solutions, big providers offer e-learning training or user guides but with very generic information. Customers can't just depend on the standardised material that comes with the purchase of the solution. Most providers offer consulting services but it's often expensive. So client companies can choose between training solutions sold by software providers or tailor-made training, corresponding to their actual use of PLM and including their specific processes, offered by consulting companies.

Without trying to be exhaustive, we present here some of the solutions available on the market and their major characteristics.

### **4.2.1 PLM software providers**

So all software providers (Dassault Systèmes, Oracle, PTC, Siemens...) offer e-learning courses to learn how to use their products. Unfortunately, we only had an overview of these platforms through each company's website, presenting the functionalities and possibilities offered by their trainings.

SAP, a German company market leader in enterprise application software offers a «Product Lifecycle Management E-Learning», a number of paid and often quite long courses that train to use SAP's standard tools. SAP customers also have an online platform, the «Learning Hub», which provides various resources and training, such as live session events, support, collaboration spaces with the possibility of asking questions to other users, as well as tips and tricks videos and learning rooms with focused resources (SAP Formation 2020). Note that some of these e-training functionalities are not available with the cheapest packages.

Siemens, another market leader, proposes a wide range of software for every stage of a product's life cycle. Siemens offers different training courses in order to take full advantage of Siemens' PLM software, highlighting the self-paced capability of e-learning. Accessible via a web browser, the platform provides e-courses presented through a regularly updated catalogue. It also includes events, training surveys, online resources, a support section with help information, FAQs, and online contact as well as online certifications depending on the e-courses taken. The platform gives access to some metrics and also allows managers to set the roles of each member in the company (Siemens 2020).

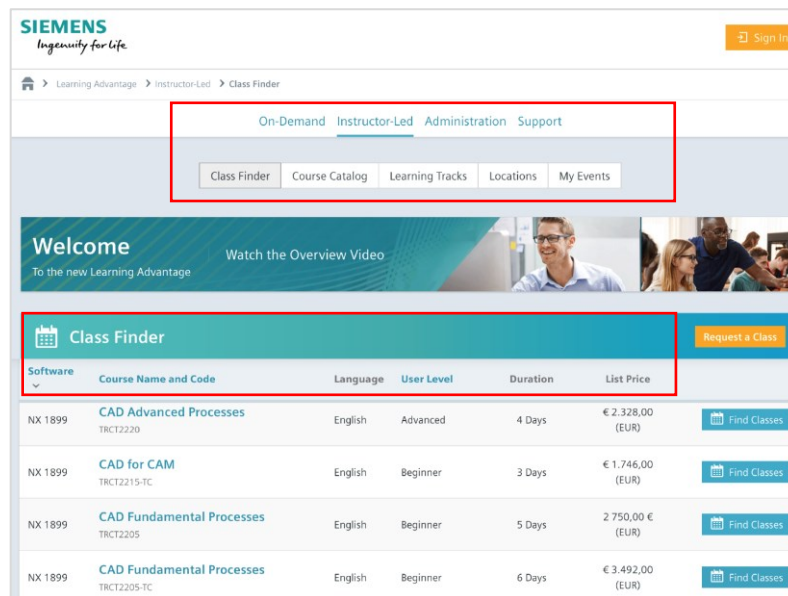


Figure 8 : Example of the interface and courses of Siemens (Siemens 2020)

#### 4.2.2 Consulting companies

CIMdata is another actor that does not design PLM software but provides strategic advices to companies working with PLM. CIMdata describes itself as «the Leader in PLM Education, Research, and Strategic Management Consulting» (CIMdata 2020). In addition to its expertise, it also creates various resources to assist companies with PLM, such as e-learning courses, webinars, and conferences, delivers certifications and creates tailor-made courses according to each company's training needs.

One of the upcoming and disruptor players in this scene is SharePLM. As it was discussed earlier, SharePLM is an e-learning provider, specialized in PLM training and consulting. Unlike its competitors, SharePLM offers a customized approach by designing and implementing tailor-made courses that meet their clients' specific needs. SharePLM stands out from its competitors by focusing on user experience, ensuring that the learning experience is interactive, modern and aesthetically pleasing. In the highly technical and complex PLM-universe, it is a skill that makes the difference.

SharePLM also offers to create Training Libraries (SharePLM 2020), platforms that provide simple and intuitive access to corporate training materials. Users can access this documentation at any time and find answers to their questions. These platforms usually include training videos, webinars, FAQs, glossaries, etc. The information is also organized according to the different roles of the company (engineers, developers, managers, consultants...), or based on processes, allowing everyone to easily find the information and courses that are useful to them. Below is an example of a Training Library created by SharePLM for OpenBOM, one of their clients.

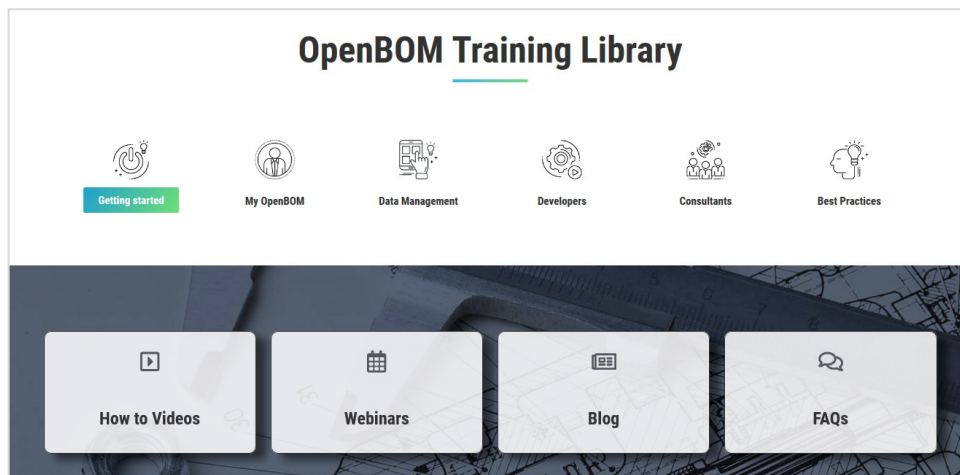


Figure 9: Example of a Training Library made by SharePLM for OpenBOM (SharePLM 2020)

### 4.3 Conclusion

These examples show us the diversity of e-learning solutions available on the market: whether it's called «PTC University», «Companion Learning Space» (by Dassault Systèmes) or «SAP training», they all aim to train users in efficient use of the software so that companies can take full advantage of their PLM solution.

As we've seen, several factors make the creation of e-learning training even more complex and difficult to achieve. There is not one kind of learner but several, according to their role during the lifecycle, and this should be reflected in the training. For example, some learners working with a CAD system will have a more technical profile, while the sales or marketing person will have a completely different profile. The training will have to consider different perspectives in order to meet everyone's needs, alternating between generic and specific training. The training and the tone used will be distinctive regarding the different groups and roles represented in the company.

In addition to the initial training, employees must continue to be trained to keep their skills up to date. Indeed, PLM solution providers are constantly adding new features to their technology portfolio, in order to innovate and integrate new functionalities (such as advanced data analysis, 3D visualization, artificial intelligence and machine learning, or the IoT). These are all changes that users must constantly face and adapt to. Hence the importance and usefulness of training to learn and be up to date on the different functionalities offered by their work environment (Quadrant Knowledge Solutions 2019).



## 5. Data collection

### 5.1 Online survey

#### 5.1.1 Methodology

The purpose of this survey was to evaluate training programs and to understand the respondents' experience and attitude towards e-learning. In order to obtain as many responses as possible, we did not restrict ourselves to companies working with PLM and broadened our research spectrum.

We developed the survey on Google Form and first shared it on LinkedIn on May 21, 2020. The link was shared on SharePLM's profile and on specific PLM groups in order to reach mainly PLM users. Later, on June 19th, an email was also sent to 12 managers (SharePLM's customers) asking them to share it with their teams.

Respondents were invited to complete the questionnaire regardless of their geographical location, size of the company, or position within the company. To ensure the anonymity of respondents, their position in the company and seniority are not included in the appendix of this work.

#### 5.1.2 Survey design

The questionnaire, available in the annex 1, consists of 47 questions and mixes multiple-choice questions, questions with text responses, and questions with a Likert scale to measure the respondents' attitudes. The first question is generic for all respondents. Then 2 «paths» are possible depending on whether or not the respondents have taken an e-course within their company. People who have already taken an e-course at work have 46 questions (maximum) to answer (categories 1, 2, 3, 5, 6, 7 below). People who have never taken an e-course at work answer 18 questions (maximum) in categories 4, 6 and 7.

The questions were divided into the following categories:

1. E-learning course: these questions concern people who have taken an e-course. They are general and intend to provide a general picture of the e-learning course;
2. Perceived impact: these questions ask about the respondents' perceived impact of the e-course;
3. Satisfaction and general impression: these questions measure respondents' satisfaction and overall impression of the last e-course they took;
4. Never taken an e-course: these questions only concern people who have never taken an e-course within their company. The questions are not numerous because we mostly wanted to understand the practices of people who have followed an e-course;
5. E-learning in your company: these questions aim to have a global vision of the place that e-learning occupies in respondents' companies;
6. E-learning at work (in general): these questions are generic to all respondents. They aim to find out their vision of e-learning in the workplace and are mainly hypothetical questions;

7. Socio-demographic issues: the purpose of these questions is to establish a general profile of the respondents. It should be noted that they have been placed at the end not to discourage people from taking the survey.

### **5.1.3 Hypotheses**

We made several hypotheses based on what we found during the literature review. For instance, H3 and partly H2 are inspired by the theory of communities of practice formalized by Wenger in 1998. We also integrated several factors that have been identified as essential to the transfer of knowledge or the adoption of e-learning, such as the environment, the importance given to e-learning by the company and motivation. These hypotheses have been discussed and reviewed several times. As a result, through the survey, we wanted to respond to the following 5 hypotheses:

H1: The duration of the e-learning has an impact on employee's motivation to follow it;

H2: The value placed on e-learning by the organization has an impact on employee's motivation to take an e-course;

H3: Social interaction\* acts as a facilitator to e-learning adoption \*(e.g. peer support, knowledge exchange, feedback ...);

H4: After an e-course, positive transfer occurs for employees who can apply their new skills/knowledge to their work;

H5: Future use intentions and motivation are lower for employees in companies with no allocated time for e-learning.

## **5.2 Interviews**

### **5.2.1 Methodology**

In addition to the quantitative data collected with the online survey, we also conducted interviews that allowed us to obtain qualitative data.

It was particularly difficult to obtain interviews. Initially, SharePLM provided us with a list of clients that we contacted by email, but without success. We then carried out a targeted search on LinkedIn (using keywords such as PLM, e-learning, change management). Following this research, we obtained 3 interviews with professionals with various backgrounds and profiles : one advisor & consultant in project management, optimization etc. (interview 3), one business consultant in PLM (interview 1) and one HR learning & development manager in a Swiss private bank (interview 2). For confidentiality reasons, neither the names nor the companies of these individuals are included in this work.

Interviews were then conducted remotely, via Skype, BlueJeans and by phone. With the agreement of the respondents, the interviews were recorded to facilitate their transcription. Interviews lasted between 30 minutes and one hour, for a total of over 2 hours. On the basis of these verbatims, we then developed a codebook to analyse the responses.

### **5.2.2 Questions**

We have opted for semi-directive interviews in order to partly orient the discourse of the interviewees on the subjects and hypotheses that interested us for this work. The questions

were adapted according to each respondent's background and role, but remained similar by focusing on the same topics. Below is an example of the questions that were asked:

1. Can you tell me about your role in the company?
2. How are e-learning programs conducted in your company?
3. How do you know if employees are motivated to take e-courses?
4. In your experience, what are the obstacles (factors, reasons) to the adoption of e-learning by employees?
5. How do you improve e-learning in your company?
6. What are you doing to increase the use of e-learning by employees?
7. Do you think the duration of an e-course has an impact on employee's motivation to follow it? Do you have an idea of the ideal duration of an e-course?
8. Do you think it is important, or necessary, to have a follow-up after an e-course? If yes, in what form?
9. How do you measure or verify that the concepts acquired during the e-courses are then implemented or used by employees?

### **5.2.3 Hypotheses**

We used the same 5 hypotheses as for the online survey. However, due to lack of time (the people interviewed being at work, they had limited time to devote to us) hypotheses 4 and 5 could not be verified or disproved.

## 6. Results

### 6.1 Analysis of the survey

Responses were collected through Google Forms between 21 May and 29 June 2020. A selective sorting was necessary, as we got 57 responses, but looking at them more closely we noticed that some responses had been doubled or even tripled for an unknown reason. After this cleanup, there were 50 responses left.

Note that since no question was mandatory, there were sometimes less than 50 answers or more if the question allowed for more than one answer. All the answers are available in the annex 2 in graphical presentation; for space reasons, we have not included all the graphs in our analysis in section 6.1.2. Given the large number of questions, we decided to analyse the results based on the initial hypotheses.

#### 6.1.1 General results

We collected 50 responses to the survey, 24 of which were from companies active in the field of PLM. 16 companies had more than 5'000 employees, the majority of respondents were between 25 and 34 years old and a majority was men (70% of respondents).

Table 6: Name of the company or activity area of survey's respondents

	Related to PLM		Other ...
1	Aerospace	1	A Bank
2	Dassault Systèmes	2	Advisor
3	Electrolux	3	App tech
4	Everis NTT DATA	4	Banque Pictet
5	Fashion industry (clothing)	5	Business Intelligence
6	Freelance / PLM consultant	6	Clarins S.A
7	Fujitsu Consulting India Private Limited	7	Configuration Management
8	Ganister	8	Consulting in Digital, Technology, Engineering
9	Google	9	Digital Marketing
10	IT services PLM	10	Ernst & Youngs
11	IT System Engineer, Windchill Business and System Administrator	11	Etat de Genève
12	Philip Morris Intl.	12	Finance / IT
13	PLM (1)	13	Furniture (RGE Trading)
14	PLM (2)	14	Import & Trading
15	PLM (3)	15	Mass media
16	PLM (4)	16	OFAC
17	PLM (5)	17	PPS Consultoria e Projetos (Consultoria)
18	PLM Administrator	18	Real Estate
19	PLM and Engineering platforms	19	Retail business
20	Share PLM	20	Technology
21	Siemens digital industry partner		
22	Tata Consultancy Services		
23	Technia		
24	Watch making		

66% of the respondents had already taken an e-course at work, and 26 out of these 33 respondents had taken at least 2 e-courses in the last 12 months. The last e-course had been taken in the last month for 17 people (note that the questionnaire was sent during the COVID-19 pandemic, which may influence the number of people who have taken a course during this period as most countries have applied more or less strict containment and a ban on going to workplaces).

### 6.1.2 Analysis based on initial hypotheses

H1 : The duration of the e-learning has an impact on employee's motivation to follow it

Most respondents took the course out of obligation or necessity (21 people), and 16 people took it out of personal interest (question 6). In terms of where the course was taken, 60% took it at work and 48% at home (question 8). 48.5% followed the e-course in several times, 51.5% in one go (question 9). Overall, respondents were motivated or very motivated to take their last e-course, as shown in the graph below:

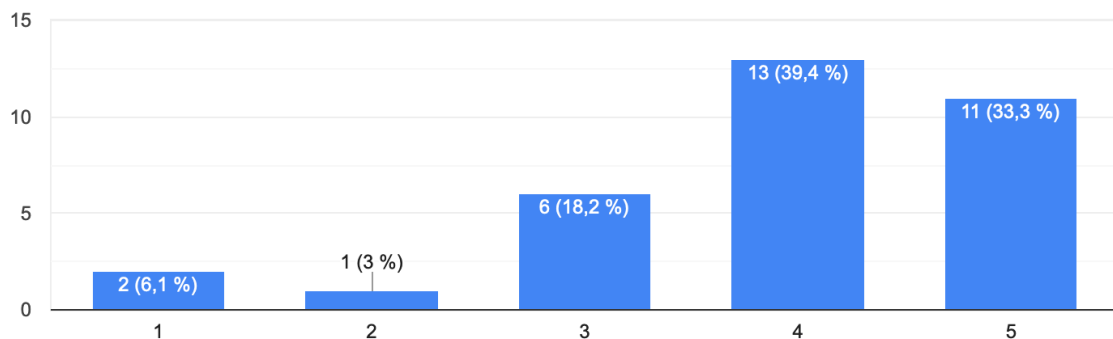


Figure 10: Question 7: «I felt motivated to take this e-course» (1 = *strongly disagree* / 5 = *strongly agree*)

Added to this, the majority of people (60,6%) found the duration of the course correct:

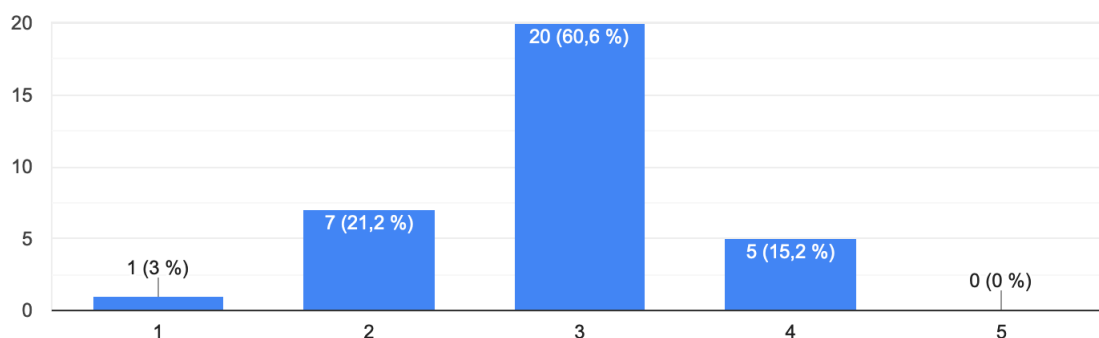


Figure 11: Question 10: «The duration of the e-course was...» (1 = *too long* / 5 = *too short*)

87.9% of participants completed the e-course: 11 people took more than 90 minutes to complete it and 10 people took between 30 and 60 minutes (figure 12).

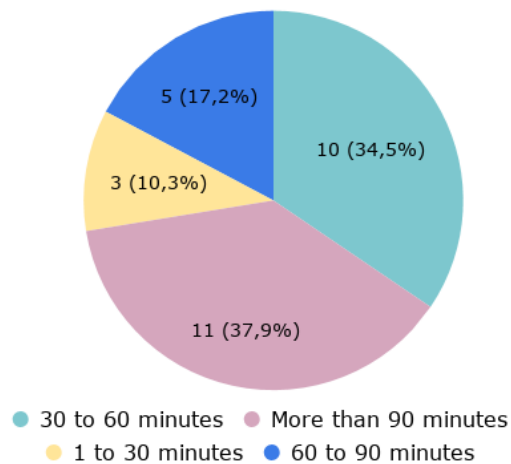


Figure 12: Question 12: «How much time did you take to complete the e-course? »

To 4 respondents who didn't complete the e-course, 3 people ran out of time and one person didn't pass a quiz that required 100% correct answers (this person had to repeat the lesson) (question 13).

In question 39 (figure 13), we see that 48% of respondents strongly agreed on the fact that the duration of an e-course would have an impact on their motivation to take it. Although we did not specify a duration because, as we see in our survey and through the interviews, the ideal duration of a course is specific to each person.

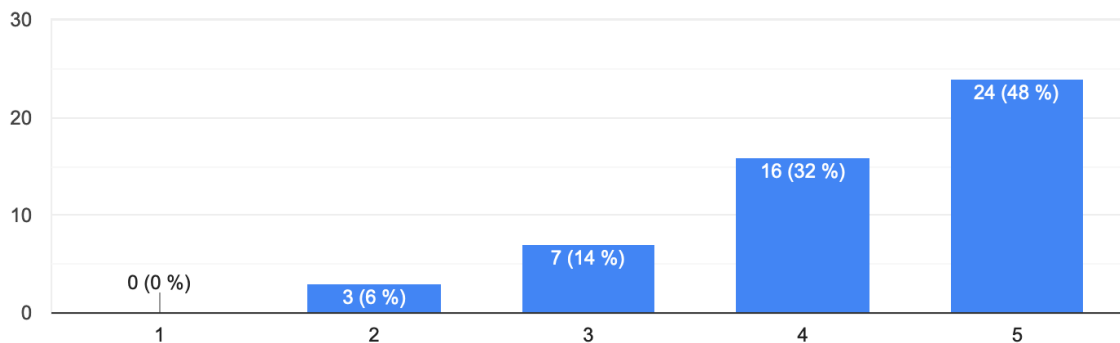


Figure 13: Question 39: «The duration of an e-course would have an impact on my motivation to take it...» (1 = *strongly disagree* / 5 = *strongly agree*)

In conclusion, we can say that the H1 is verified, the duration of a course impacts the motivation of users. However, the ideal duration of a course is difficult to determine, which leads us to suggest that methods such as microlearning should be favoured in order to allow learners to follow e-courses at their own pace.

We also highlight another element that deserves to be examined in more details: 48.5% of the respondents followed the course in several times. It would have been interesting to understand the reasons behind that (lack of time, lack of motivation, because of technical problems...). Indeed, Becker *et al.* (2013) identified in the possible barriers the «Concerns about lack of time and potential interruptions when trying to complete e-learning». Therefore, this could represent a negative factor in the adoption of e-learning by users.

## H2: The value placed on e-learning by the organization has an impact on employee's motivation to take an e-course

By «value placed on e-learning by the organization», we mean all the tools and means available to employees to help them have the most adequate and enjoyable training program possible. This can be done through feedback, follow-up, tools available as a dedicated platform, but also through the promotion that the company makes of its e-learning and the time available to employees to follow these e-courses.

Regarding the tools and means available to employees, the results of our survey showed that 81.8% of participants did not have a follow-up after the e-course (figure 14).

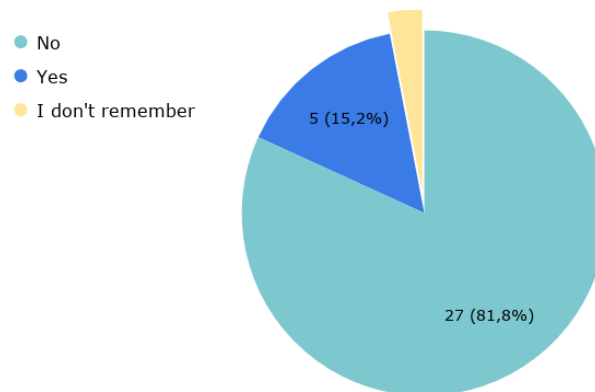


Figure 14: Question 14: «Did you have a follow-up after taking the e-course? »

Added to this, 50% of the respondents indicated that there was no platform allowing them to exchange their knowledge with their colleagues (figure 15).

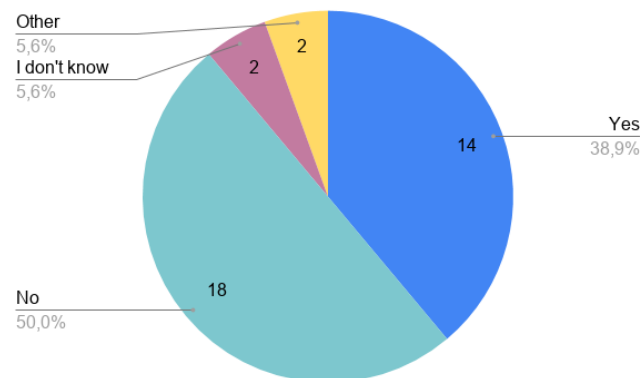


Figure 15: Question 32: «Is there a platform (or other) that allows you to exchange knowledge with your colleagues? »

Finally, 52.8% of respondents said they had access to the appropriate support during e-courses (figure 16). We can also see, with question 8, that 54.1% took the course at work, but still 43.2% took it at home (perhaps due to a lack of time available on their working hours. Note that due to COVID-19, these statistics may be biased). Finally, 88.9% of respondents have mandatory e-courses in their company (question 28).

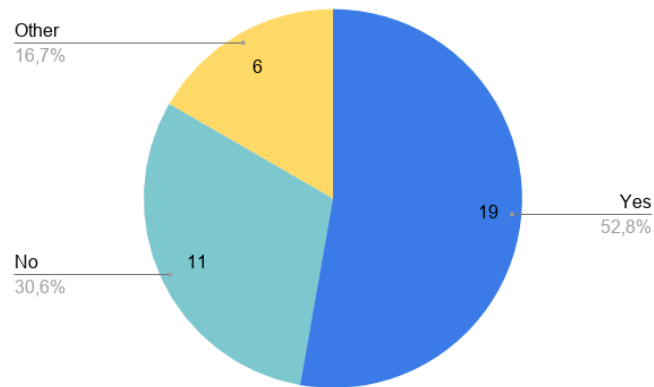


Figure 16: Question 31: «Do you feel you have access to appropriate support during e-courses? (Person, ressource center, help desk...)»

To question 29 «Does your management give you time to follow e-learning courses during your working hours» (see annex), 21.6% said *no*, 8.1% did not know and 70.3% said *yes*. Only those who answered «yes» then answered question 30 (figure 17 below), showing us that even though they had time, 23.1% did not know how much. Most people had 1-2 hours per week.

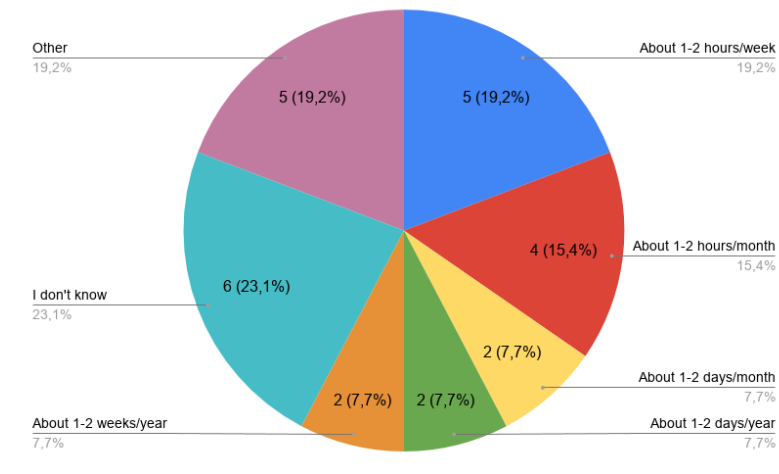


Figure 17: Question 30: « How much time do you have? »

In question 26, the vast majority of respondents agreed with the statement «Management encourages us to take e-learning courses», 38.9% even totally agreed (figure 18).

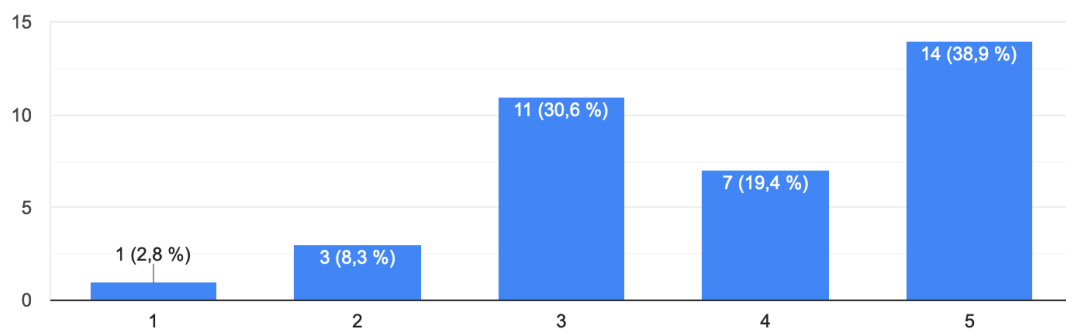


Figure 18: Question 26: «Management encourages us to take e-learning courses» (1 = *strongly disagree* / 5 = *strongly agree*)



Finally, we wanted to compare the intention to take an e-course for respondents who had taken an e-course with those who had never taken one in the context of their company. 78.8% of those who had already taken an e-course said they intended to take another one. Among respondents who had never taken an e-course, this percentage was only 47.1% (figures 19 below).

In addition, 94.1% of respondents who had never taken an e-course in their company indicated that it was because their company did not offer any e-course (question 24). It can therefore be considered that the value their companies placed on e-learning is low, resulting in a lower motivation to take e-courses.

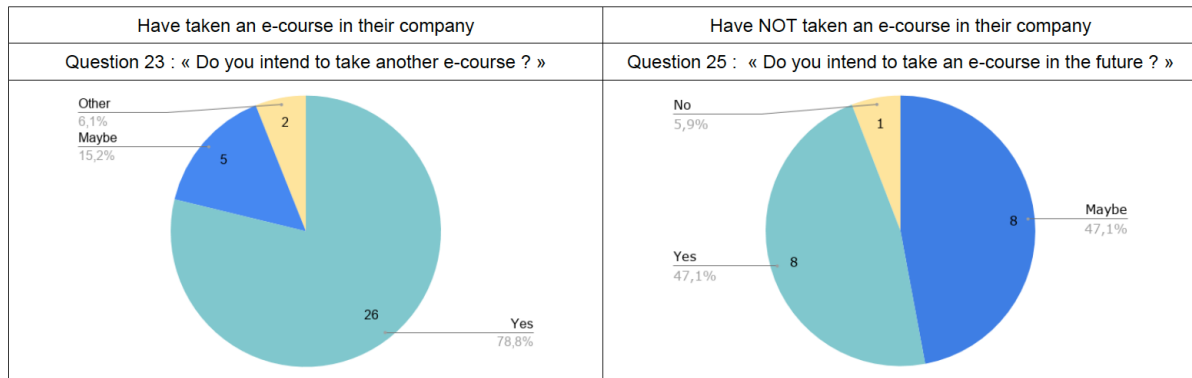


Figure 19: Comparison of questions 23 and 25 in relation to question 1

Overall, we see that companies in the survey giving a certain place and value to e-learning, encouraging employees to take e-courses (some are even mandatory), allocating time on their working hours to devote to e-learning, these companies show a higher rate of learners intending to take another e-course (78.8%), in comparison with employees who have never taken an e-course in their company. It can therefore be concluded that hypothesis 2 is verified.

However, an effort could still be made, in particular regarding follow-ups after the e-courses (more than 80% do not have one), platforms to exchange knowledge between colleagues, which are still not widespread, and for communication around e-learning. Indeed, although aware that they have time available for online training, these companies may not have clearly defined the place and time devoted to e-learning, since 23% of the respondents did not know how much time they had available, and 48.5% had taken the e-course in several times.

H3: Social interaction\* acts as a facilitator to e-learning adoption. \*(e.g. peer support, knowledge exchange, feedback ...)

If we look at the data about social interaction, we see with question 14 that 81.8% of respondents did not have a follow-up after taking the e-course.

With question 26, we see that 38.9% of participants «totally agreed» to the fact that management encourages them to take e-learning courses (19.4% agreed and 30.6% were neutral). Most of the communication about e-learning is done by e-mail, thanks to a dedicated platform or website, as well as internal advertising (figure 20).

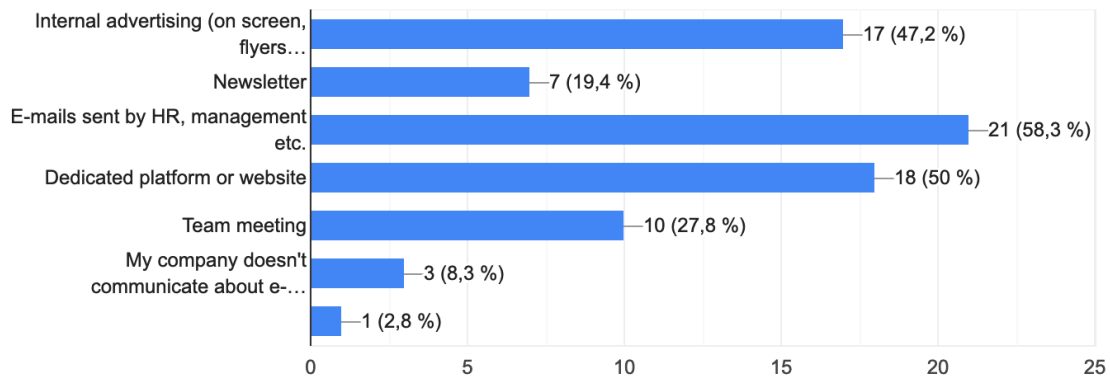


Figure 20: Question 27: «How does your company communicate about e-learning?»

Concerning the tools made available to employees to facilitate social interaction, 50% of respondents said that there was no platform in their company allowing them to exchange knowledge with their colleagues (question 32), only 38.9% indicated that they had access to such a platform.

In question 31, «Do you feel you have access to appropriate support during e-courses? (person, resource centre, help desk...)» we see that the majority of respondents (52.8%) answered «yes» and that 30.6% answered «no».

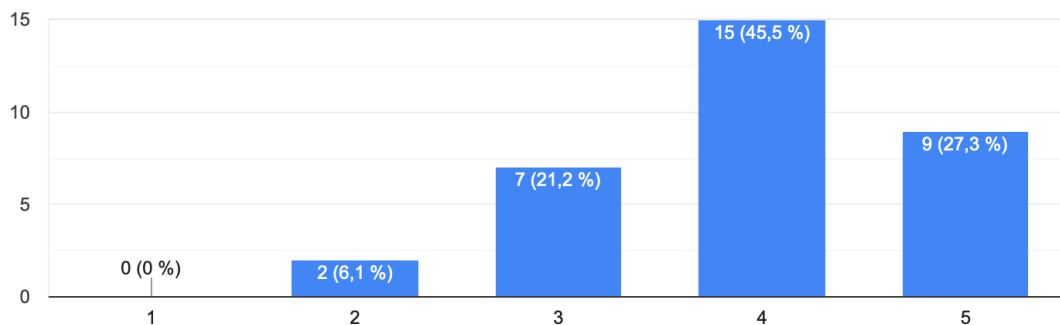


Figure 21: Question 19: «Overall, I was satisfied with this e-course» (1 = *strongly disagree* / 5 = *strongly agree*)

As for what was appreciated in the e-course (the question allowed several answers), 84.8% answered the quality of the content, 69.7% the fact that the content was relevant to their work. 45.5% also appreciated the course design and user experience as well as the duration of the course (question 21). In question 20 (figure 22), 72.7% of respondents recommended the course they took to colleagues.

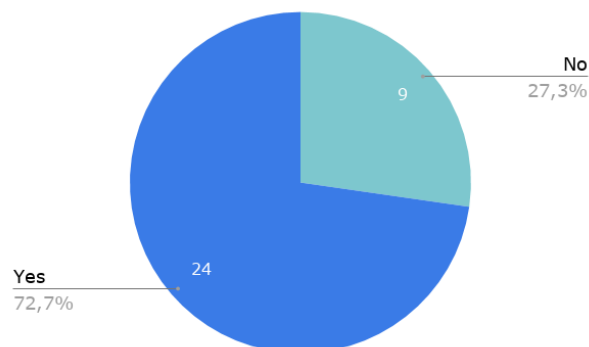


Figure 22: Question 20: «Did you recommend the e-course to other colleagues? »

We can also see that most people are inclined to receive help before, during and after the e-course, and would find it useful to have a platform to exchange with their colleagues, as shown in questions 36 and 37.

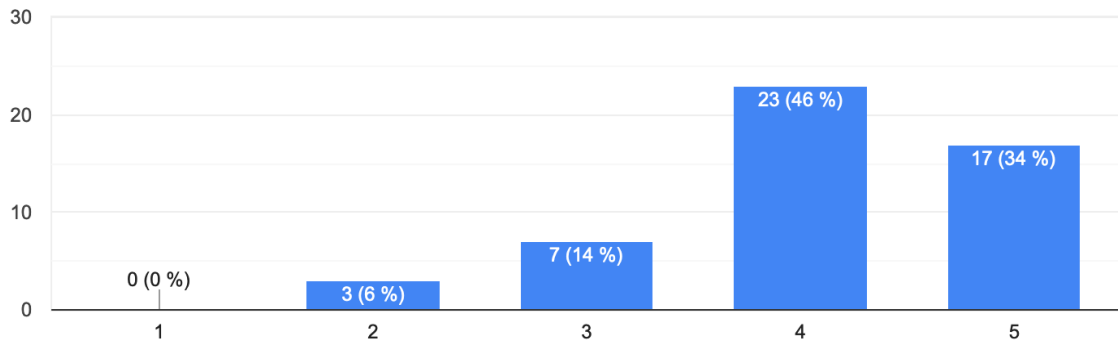


Figure 23: Question 36: «I would find it beneficial to have a platform that allows me to exchange knowledge with my colleagues» (1 = *strongly disagree* / 5 = *strongly agree*)

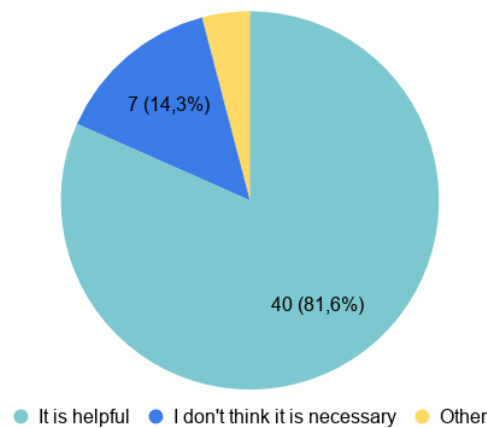


Figure 24: Question 37: «What do you think of support before, during and after training? »

With these different results, it is therefore reasonable to believe (especially if we consider questions 20 and 19) that the last e-course followed by the respondents was up to their expectations. They feel encouraged to follow e-courses by the management who promotes e-learning using various channels (e-mail, internal ads, dedicated platform...) and feel they receive adequate support. This also supports the fact that 78.8% of respondents intend to follow another e-course (question 23).

However, six «free-form» responses highlighted the importance, and sometimes the lack, of human contact and interaction during e-learning, as presented in the table

It can therefore be said that hypothesis 3 has been verified, even if obviously efforts could still be made in particular regarding interaction and making e-courses more «human».

Table 7: Free-form answers highlighting interaction during e-learning

Questions	Answers
Q42: If you have any other comments, suggestions or things you would like to share with us, please do	<i>«E-learning is good but you always need a human interaction with it. It cannot completely replace teaching in my opinion as you want to ask questions, share understanding, resume key concepts, etc. »</i>
Q33: What are your suggestions to improve the e-learning programs in your company?	<i>«Plataforma de compartilhamento de conhecimento entre colegas e outras companhias (organizações).»</i> Translation: Platforms for knowledge exchange between colleagues and other companies.
	<i>«online support»</i>
Q22: According to you, what was the weakest part of the e-course and how could it be improved?	<i>«Maybe a bit more interaction. [...]»</i>
	<i>«Lack of interaction with other learners. »</i>
	<i>«No interactions with a specialist in real time, I had to take a few notes on specific topics to ask the contact given after the elearning. »</i>

H4: After an e-course, positive transfer occurs for employees who can apply their new skills (knowledge) to their work

First of all, to question 5, most participants found the subject(s) covered by their last e-course mainly good (54,5%) to excellent for 24,2%.

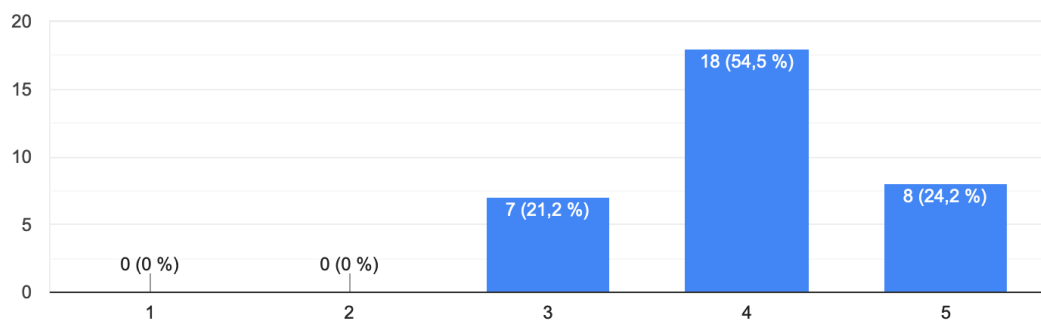


Figure 25: Question 5: «How relevant was the subject(s) to your needs and interests? » (1= poor / 2= fair / 3=average / 4= good / 5 = excellent)

In terms of perceived impact, overall participants found the content of the last e-course they took to be relevant to their work (figure 26).

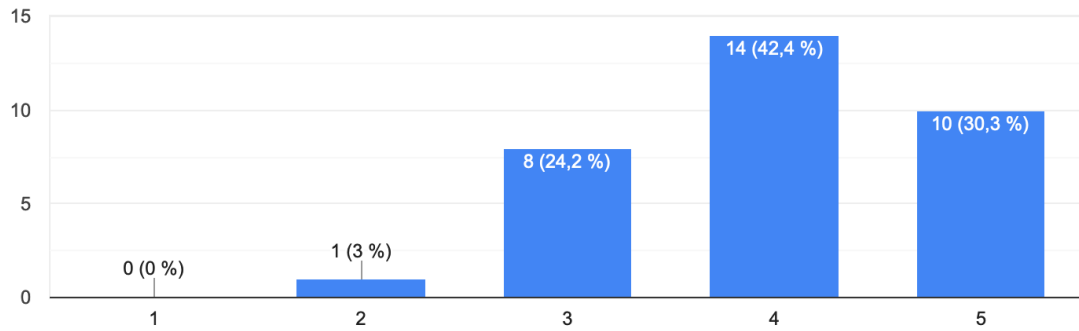


Figure 26: Question 15: «The material covered in the e-learning course was relevant to my job» (1= strongly disagree / 5= strongly agree)

As for having learned new things, the answers are more mixed, as shown in figure 27, where the number of neutral persons is slightly higher.

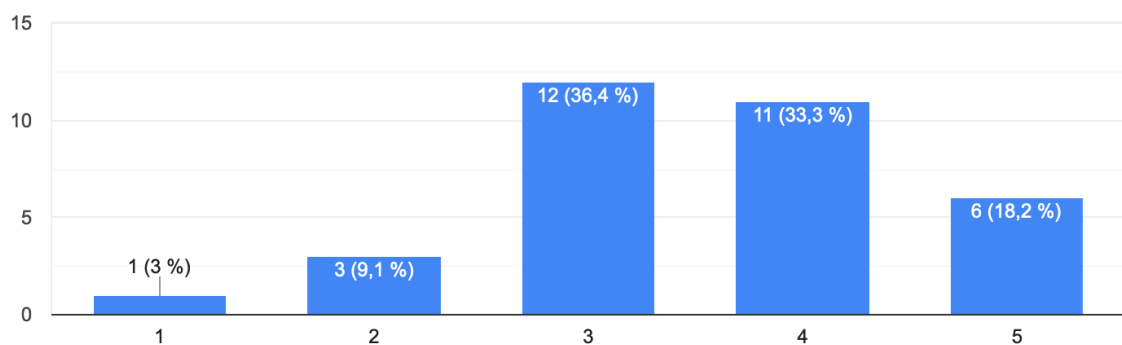


Figure 27: Question 16: «I learned new skills / tools / concepts during this e-course» (1= strongly disagree / 5= strongly agree)

54.5% of respondents were able to put into practice what they learned immediately after the e-course. 27.3% still responded that they were not able to do so (figure 28).

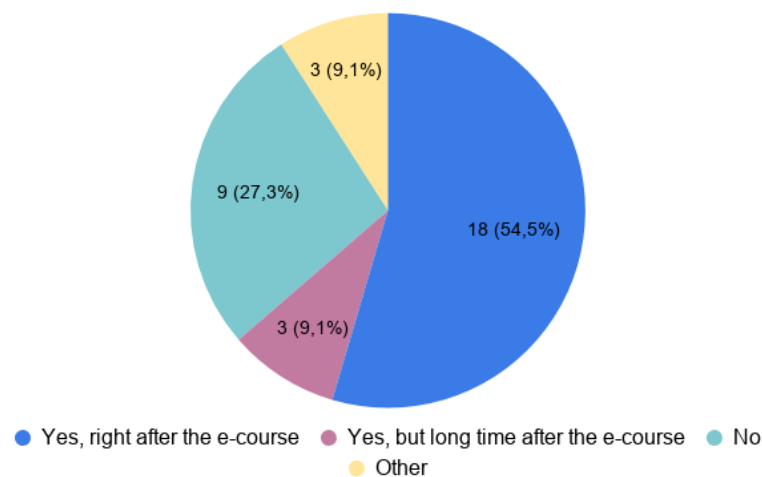


Figure 28: Question 17: «After the e-learning, I was able to put into practice the skills / tools / concepts seen during the e-course»

Finally, 45,5% of the respondents agreed (4 on Likert scale) to question 18, feeling that the e-course enabled them to do their job better.

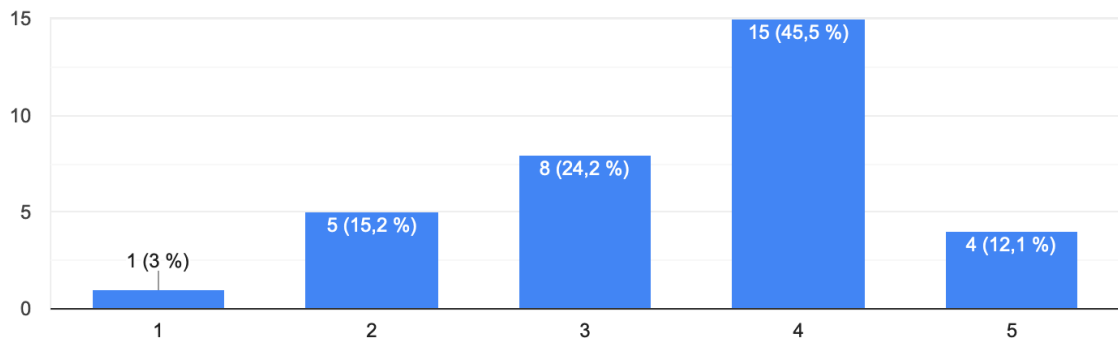


Figure 29: Question 18: «I feel that the e-learning course has enabled me to do my job better» (1= strongly disagree / 5= strongly agree)

In terms of satisfaction, the participants were overall (very) satisfied with their last e-course (question 19). This is also expressed in the fact that 72.7% of the participants recommended the e-course to other colleagues (question 20).

As defined by Curry (1994), «positive transfer occurs when learning in the training situation results in better job performance». Here we see that respondents felt that the e-course helped them do their work better and were overall able to apply what they learned soon after the e-course. We included this time notion to question 17 by adding two possibilities to the yes answer: «right after the e-course» and «long-time after the e-course» because the sooner learners can use what they learn, the more likely it is to be retained over the long term. Indeed, Wexly and Latham (2002) «suggest that although approximately 40% of content is transferred immediately following training, the amount transferred falls to 25% after 6 months and 15% after 1 year. This suggests that as time passes, trainees may be unable or less motivated to retain and use the information gained in the training program. » (Velada *et al.* 2007)

However, respondents were more moderate about whether they learned new things as a result of the e-course (question 16). Apparently, the transfer was positive, the fact that 52.8% of respondents found that they received the necessary support (question 31) may also have had a positive influence on the transfer. Indeed, Merriam and Leahy (2005) found in their research a better degree of transfer for learners who felt they received support from their supervisors and peers.

##### H5: Future use intentions and motivation are lower for employees in companies with no allocated time for e-learning

First of all, extending hypothesis 5, we can see from questions 23 and 25 that people who have not taken an e-course in their company have less intention of taking an e-course in the future. It should be noted that most respondents who did not take an e-course in their company indicated that it was because their company did not offer e-courses (figure 30 below).

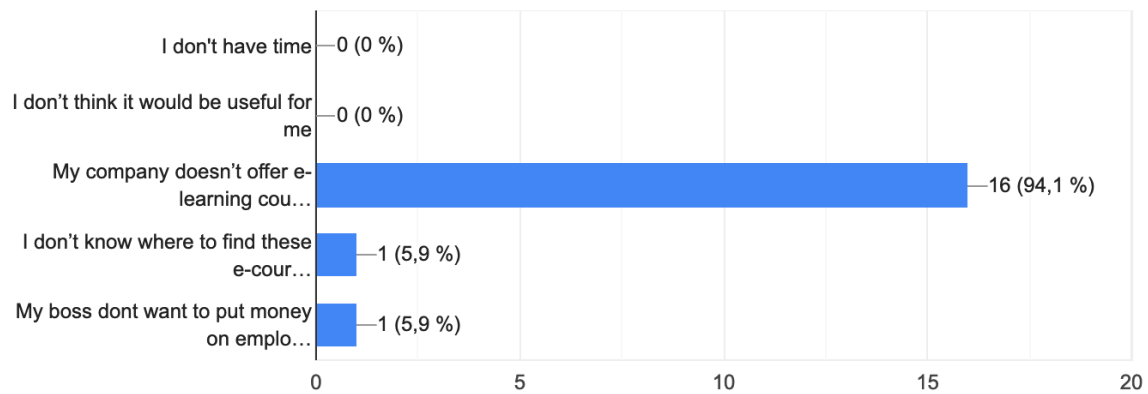


Figure 30: Question 24: «Why have you never taken an e-learning course offered by your company? »

We then compared the responses of those who answered «yes» to question 29 as to whether management gave them time during their working hours for e-learning with those who answered «no» to the same question. It should be noted that the people who answered «I don't know» were deliberately left out, in fact out of the 3 answers, 2 had incomplete answers (NA).

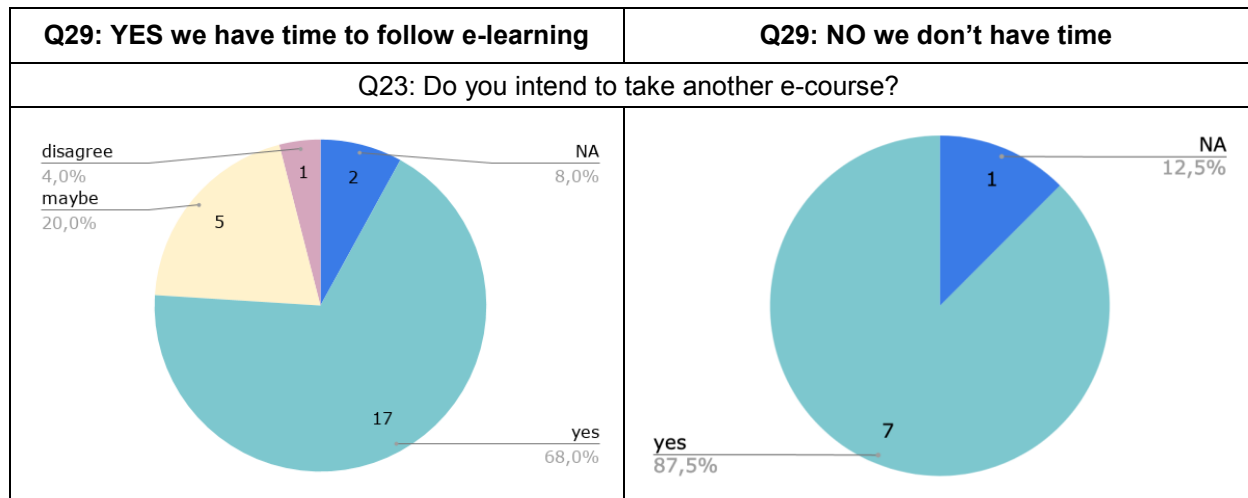
To question 29: «Does your management give you time to follow e-learning courses during your working hours? », there were 8 «no», 3 «I don't know» and 26 «yes». The first relevant point is that more people answered yes to question 29, which is reflected in the diversity of responses to question 7 (table 8). 50% of respondents who did not have time dedicated to e-learning on their working hours «strongly agreed» to the question on motivation, compared to 24% for those who had time available on their working hours. The number of «agree» is very close for both categories. What still differs is the number of neutral responses: 24% for those with time, and none for those who answered «no» to question 29. One person with time available also answered «disagree» as to his motivation to follow this e-course.

Table 8: Analysis of question 7 in relation to question 29

Q29: YES we have time to follow e-learning	Q29: NO we don't have time
Q7: I felt motivated to take this e-course	
<ul style="list-style-type: none"> <li>agree</li> <li>strongly agree</li> <li>neutral</li> <li>strongly disagree</li> <li>disagree</li> <li>NA</li> </ul>	

Then if we consider the future use intention, we can see that 87.5% of people with no specific time for e-learning at work intend to follow another course, compared to 68% of people with time. As before, the responses of people with time are more varied: 20% answered «maybe», 2 people (8%) answered nothing and 1 person «disagree».

Table 9: Analysis of question 23 in relation to question 29



In summary, hypothesis 5 is not verified. On the contrary, we find that motivation and future use intention are higher among people who do not have specific time allocated by their company to follow e-courses during their working hours.

### 6.1.3 Difficulties

We realised when analysing the results that we had been too ambitious regarding this survey. Indeed, the number of questions was high and it took us a long time to analyse them. The lack of time and adequate tools also prevented us from taking full advantage of the data we had collected.

In addition, the hypotheses were determined prior to the survey. The questions were then adapted and modified several times in order to best respond to these hypotheses. Despite this, we felt that the hypotheses were too complicated.

## 6.2 Analysis of the interviews

### 6.2.1 Methodology

As mentioned earlier, we have developed a codebook to enable us to analyse as accurately and objectively as possible the responses obtained during our interviews.

To help us in this task, we used the paper written by DeCuir-Gunby (2011). It contains a definition based on Miles and Huberman's paper (1994): «Codes are defined as 'tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study and their development is the initial step in analyzing interview data». The creation of a codebook, which brings together codes, definitions and examples, is the first step in the analysis and interpretation of qualitative data collected during an interview. Some codes can be determined from existing concepts or theories, they are called theory-driven, while others can emerge from the raw data collected and are referred to as data-driven codes (DeCuir-Gunby 2011).



In our analysis, some codes have been determined based on the theory found during the literature review (theory-driven) as can be seen in the table below, while others have emerged from the raw data. Several readings and analyses of the verbatims were necessary to develop the codebook. In a first version containing 16 categories, we noticed that the categories «measuring learning outcomes» and «follow-up» were very alike, and the participants' responses were also similar. They were therefore merged. The category «encourage» was also merged with «motivation» because the two were confusing and their purpose was the same. Finally, the category «difficulties» was merged with «barriers» and the category «reticence» was removed because it was part of the barriers.

Table 10: Codebook

Type of code	Categories	Code ID	Description	Example
Theory-driven	Motivation	MOT	Indicators of motivation. The aim is to understand what are the factors/elements that can influence people to follow an e-learning. Includes elements put in place to encourage employees to follow e-learning courses.	<i>"To motivate employees, they should see the usefulness of taking the course. Especially they should have a quick return: acquire basic knowledge in a few hours."</i>
	Adoption	ADOP	Indicators or leads to increase the adoption of e-learning by users.	<i>"You can do things with points or badges that you receive depending on the training you complete. Like gamification."</i>
	Barriers	BAR	Indicators of barriers to e-learning adoption. Includes difficulties encountered while taking an e-course.	<i>"The main barrier in our company is the technology and the problems you have with your computer or when taking a course."</i>
	Duration	DUR	Indicators of the impact of duration on the motivation to take an e-course.	<i>"Yes, the duration has an impact on employees motivation. The longer it takes, the less people will want to do it, that's for sure!"</i>
	Achievements measures	ACH	Indicators of elements allowing to measure employees' achievements after an e-learning course. Includes indicators of a follow-up after an e-course.	<i>"There are quizzes at the end of some training sessions to see if they have understood correctly. It is possible to see the success rate."</i>
	Organizational culture	ORG	Indicators of measures put in place by the company to encourage employees to follow e-courses and promote the e-learning (e.g: dedicated platform, available time during working hours...)	<i>"Employees have time out of their working hour to take online courses."</i>
Data-driven	Usefulness of the e-learning	USE	Indicators of the usefulness of the e-learning in a work/PLM context.	<i>"It is interesting if you need to quickly acquire knowledge (e.g: learn how to use a new PLM functionality)"</i>
	Face-to-face training	FAC	Indicators of the usefulness of face-to-face training. Includes its advantages and disadvantages, when it should be used.	<i>"Depending on the training, it is better to have face-to-face. Or a combination. For things that are much more practical and much more relational and human, it is better to have a face to face."</i>
	Assistance	ASS	Indicators of measures put in place in order to help employees when they encounter difficulties, have questions or need technical assistance.	<i>"For each course you can find the course owner and if you have a question you can contact that person and ask your question."</i>
	Platform	PLAT	Indicators of the use or the aim of a platform in an e-learning context.	<i>"The idea of a forum is good if your are looking for information. Like an FAQ. It exists at PTC but you have to be part of their user community. But it need to be well maintained and if you don't find what you are looking for there is a risk of discouragement and no further use."</i>
	Improvements	IMP	Indicators of solutions or ideas that exist or that could be put in place to improve e-learning.	<i>"Allow employees to redo only the part of an e-learning that has not been understood."</i>
	Obligation	OBL	Indicators of obligation to take an online training. Includes when e-learning or specific e-courses are mandatory in a company.	<i>"For mandatory training, they have no choice. If they do not follow the training they receive a reminder. Therefore participation rates are very high, 95-97%"</i>

## 6.2.2 Analysis based on initial hypotheses

First, we analyzed the responses according to our 5 initial hypotheses. Then, we also highlighted other elements that emerged from the interviews (part 6.2.3 below).

### H1: The duration of the e-learning has an impact on employee's motivation to follow it

All 3 of our respondents answered positively to this hypothesis. In interview 2, the person stated that the longer a course lasts, the less people want to do it (referring to his own experience in HR). In interview 3, the respondent indicated that it was important to have time available on one's working hours, but that it was also important to establish clear rules. Finally, the interview 1 was the most nuanced. Initially he said that in his opinion time did not play a role on motivation. But then he added that if employees were asked to take on their own time to follow e-learning courses, it could become a barrier.

### H2: The value placed on e-learning by the organization has an impact on employee's motivation to take an e-course

In interview 1, it was indicated that the duration was half a barrier to taking an e-course, which also depends on the context of the company (i.e. whether or not it favours e-learning). If we take the example of interview 2, in a bank's context, we see that they invest a lot of time and money in their e-learning (mandatory e-courses, reminders sent by e-mail, a dedicated platform etc.) and the use of the e-courses is very high. But given the little information collected, it is not possible to validate or invalidate this hypothesis.

### H3: Social interaction\* acts as a facilitator to e-learning adoption. \*(e.g. peer support, knowledge exchange, feedback ...)

The question was asked about the usefulness and relevance of having follow-ups after e-courses, and all respondents associated follow-up with evaluation. They mentioned the possibility of having a quiz at the end of the e-course and some «check points» once the courses are online, in order to collect data and have statistics to improve future courses and to find out if they have a positive effect on employees' work.

All the respondents spontaneously mentioned face-to-face training, indicating that it should be favoured in certain situations and that face-to-face training was necessary even if e-learning was available in companies. They also mentioned the lack of humanity in online courses. The relational aspect acting, in their opinion, as a facilitator and motivating learners to take e-courses. In interview 1, he also mentioned that in the best e-course he had seen, a real person was filmed explaining step by step how to use some tools and features of the PLM system.

As for the use of a platform for exchanging knowledge, interviews 1 and 2 found it relevant but 1 specified that it would require a lot of work and investment from employees to make the platform operational.

Given the answers and despite the misunderstanding of the question, it is possible to say that this hypothesis is verified. We can, indeed, state that for all respondents the human factor plays a predominant role in e-learning and that, as we said, the relational aspect is acting as a facilitator and motivating learners to take e-courses. All of them also deplored a lack of interaction and exchange in e-courses.

H4: After an e-course, positive transfer occurs for employees who can apply their new skills (knowledge) to their work

This hypothesis could not be verified or invalidated. Indeed, since the respondents had limited time to devote to us, all the questions could not be asked.

H5: Future use intentions and motivation are lower for employees in companies with no allocated time for e-learning

The question was not asked explicitly. Interview 2 was the only concrete example of a company where employees have available time for e-learning and are even required by law and by the company to take certain e-courses. The use was therefore high, but no indication of future use intention was given. As for motivation, the respondent told us that it was high, but it is still highly influenced (or even biased) by its mandatory nature.

It is therefore difficult to answer this hypothesis with the information we have collected.

### **6.2.3 Major suggestions, ideas and comments**

In addition to the results that emerged regarding the hypotheses, we have gathered here other elements that we feel are relevant and came to light with the interviews.

#### Interview 1, PLM consultant's perspective:

- The respondent indicated that it would be useful to help increase user's adoption in a PLM context to allow employees to practice on a learning platform (a sandbox). This represents the standard version of the software provided by the vendor, implemented without any customizations or adjustments. This would allow employees to train, experiment, and test things according to the training given in the e-learning. This test environment is useful to do the practical steps of an e-course.

#### Interview 3, change management's perspective:

- The respondent repeatedly emphasized the importance of a connection between people. He mentioned the idea of creating a link between employees to motivate and bring them together, in order to break this «inhuman» side induced by e-learning.
- Speaking of possible barriers, he mentioned the fear of change as well as resistance to change. To remedy this, he said we must try to convince users by insisting on the relational part. He also mentioned the difficulty of staying motivated and concentrated for several hours in front of a screen in the absence of human contact.
- Regarding follow-up: he suggested, before the course, to present the e-course, explain the features and how to use it, and show the benefits of taking it. And after the course, he advised to obtain statistics by asking for feedback from the participants (through a questionnaire for example) in order to improve future e-courses. At the same time, establish a link with the team leaders to find out if there has been a visible effect of these e-courses on employees' work.
- An another interesting element, which we did not find in the literature, emerged from this interview with the idea of involving learners in the phase prior to e-course design to ensure the relevance of creating an e-course. This idea of responding to a need

seems very relevant and could save time. The interviewee also mentioned the fact that if the e-course that was created responds to a need, the motivation of the learners should also be higher.

#### General comments:

- All of them indicated that duration has an impact on the motivation to take courses, which is why it is important to provide the right structure for employees: time available during working hours and clear rules.
- In interviews 1 and 3, they indicated that employees need to be able to understand the usefulness of each e-course. It is therefore important to show them the benefits they will get and explain why certain changes are being made. By understanding the benefits and impact of taking an e-course as well as its purpose, employees will be more inclined to take online courses. This idea is in line with the first barrier identified in Becker *et al.* (2013) study: «The nature of e-learning as a learning approach».
- Interviewees 1 and 3 also talked spontaneously about gamification by proposing the possibility of obtaining badges, points or even credits by following e-courses in order to motivate employees.
- In all three interviews, technology emerged as the main barrier to the adoption of e-courses, including poor interface, computer bugs and user experience. In interview 3, he also talked about fear and resistance to change as a possible barrier.

#### **6.2.4 Difficulties**

As they mentioned in DeCuir-Gunby's (2011) article: «it [creating a codebook] can easily become an overwhelming challenge if undertaken by one person», which have been the case for me. Indeed, the various steps involved in its development were time-consuming and complicated.

Moreover, by making this codebook alone, I was the only coder so the positive point is that I was consistent in the coding. In this situation, having only 3 interviews was also a great help for me by making the task less complex.

However, carrying out the analysis and interpretation alone created a lot of problems, mainly by giving only one point of view, which didn't allow for dialogue and discussion about code choices. Overall, my choices were based mainly on theory and the codes were reviewed several times as the data was re-examined.

## 7. Recommendations

Based on our research and the data we collected, we present here some suggestions and ideas to improve e-learning adoption in a PLM context.

### 7.1 Getting feedbacks

First of all, creating a feedback procedure would allow SharePLM to improve its courses. The idea is to define a strategy to collect information on the courses created, to understand their impact on users, to identify strengths and areas that could be improved. This would allow to customize the courses even more.

The post-course survey that we proposed (see annex 3) is a first element of this strategy and will enable SharePLM to obtain feedback from the learners. This needs to be completed by determining a time frame (is it more relevant to send the questionnaire immediately after the course or 2 weeks later?), but also by creating a specific questionnaire to obtain feedback from managers, HRD and team leaders for example, in order to have an overall view of the course, its impact and to assess whether there has been a positive transfer. SharePLM could perhaps also obtain data collected via the companies' LMS (if they have one) in order to have even more accurate statistics.

This would allow SharePLM to work more closely with their customers. By having an idea of the impact of their courses, identifying users' motivations and measuring their satisfaction, SharePLM will be able to offer training that is aligned with their ambitions.

### 7.2 Humanizing e-learning

Human presence is not a component of the core nature of e-learning. Although technology allows many advantages (learning where and when the trainees want, customizing the training path...) the human aspect is missing and affects users' motivation and satisfaction. Aristotle, the Greek philosopher, emphasized that man is a social animal, life in society is man's natural state, and the loneliness involved in living outside of any social group would be unbearable for him. Therefore, one of the major challenges of e-learning lies in its ability to recreate this community, enabling to build a link between users. Involving learners, making them interact, allowing them to convey ideas: in other words, creating a group with a common language and common values would give e-learning its full strength.

#### 7.2.1 Interactivity

Increasing interactivity is therefore essential. The complexity of PLM and the fact that it was developed by engineers for engineers makes the creation of interactive, user-friendly e-courses even more difficult. To try to humanize this, SharePLM could add as an introduction and conclusion to its courses, a video with a real person presenting the upcoming lesson and motivating users to take the course. Then, getting into the program the learner will follow step by step what needs to be done.

#### 7.2.2 Support

Imagine, you're taking an online course and here's a topic you have questions about. Worse, in the middle of a quiz, you get stuck on a question and can't move on to the next lesson. Nothing could be more annoying! You hesitate to give up because you don't want to waste too much time.

As an extension of the previous idea, it would be interesting to give users the possibility to contact the course creator or a referee at any time during the training. The process should be simplified as much as possible and made as "normal" as possible, without any shame for the user. For example by using a button or a chat that can be accessed at any time during the training, so as not to get stuck and wait until the end of the course to get in touch with someone and risk forgetting the question or abandoning the course before the end. By transforming a simple help «button» with the image of the person introducing the course, it would add a little humanity that could be beneficial for the course and bring back that human side that is lacking.

### **7.3 Time**

The time spent on e-learning as well as the duration of a course plays a major role in the adoption. It is not enough for a company to tell its employees that they can take e-courses. Imagine yourself at your workplace on Thursday afternoon, you have decided to devote 2 hours to an e-learning course. But your colleagues need information, others want to share a coffee break with you, and in the end you find yourself constantly bothered. You can't follow the course properly. It doesn't matter anyway, you already know the subject, at worst you will do it at home.

To remedy this, a company can define a fixed time slot to devote to e-learning. All employees are thus busy at the same time perfecting their knowledge on a subject. However, depending on each employee's schedule and work rhythm, this solution can be restrictive and removes the "just-in-time" nature of e-learning.

We therefore propose to define a place in the company dedicated to e-learning. A kind of classroom (be careful not to integrate elements that would remind employees of school and risk blocking them) that would create a specific space where learners would not be disturbed. This could also encourage exchanges and bring back that human side that is missing.

### **7.4 Gamification**

Gamification was mentioned in the interviews and we also saw from the questionnaire that 74% of respondents would be enthusiastic or even very enthusiastic about the idea of following an e-course with gamification (question 41). Solutions exist and allow, for example, learners to earn points according to the number of e-courses they follow and to obtain certifications recognized in the company and even beyond. This can be an interesting solution to motivate users to take e-courses and challenge them to climb levels.

### **7.5 Microlearning**

It is also apparent from the literature and our survey that the needs but also the learning preferences of each learner are very different. At present, online courses have difficulty in meeting everyone's expectations. One solution may lie in the customization of courses through microlearning. Making courses available in a fragmented way could allow learners to choose what suits them best and thus create their ideal learning path. But also by avoiding making mandatory parts a learner would have the choice of whether or not to follow certain lessons and do some exercises without missing important information. However, such an idea would require a considerable effort in terms of pedagogy and time.

## **7.6 Limitations**

Given the breadth of e-learning topics and the complexity of PLM, we were forced to limit ourselves and give a framework to our research. Certain parameters were not taken into account, for example, we did not distinguish between the size of companies. This can be important, however, as the means and dynamics are different depending on the number of employees and the size of the company. The notion of time, although essential in e-learning, has not been explored in depth either.

It would also have been interesting to be able to analyze and understand how the e-courses of PLM software providers are made, unfortunately we have not been able to access such information.

## **7.7 Future works**

In order to deepen certain notions and to go further in this work, we suggest for future research, to go and see the work done in the field of change management and to deepen the notions of resistance to change, which can impact the adoption of e-learning.

Research into existing tools to make courses more interactive can also be beneficial. It would in addition be relevant to better understand how to define a strategy and identify what steps are necessary for its development and implementation.



## 8. Conclusion

In conclusion, this work allowed us to highlight the concepts inherent to e-learning, which bring together notions related to both technology and education. In other words, e-learning has to meet the challenges of learning by being able to motivate users, provide exercises and contents that are problem-oriented, allow immediate application in daily work and give learners the opportunity to share their ideas and knowledge with their peers.

E-learning must also take up the challenges related to technology by offering an easy-to-use and intuitive interface, providing the adequate and necessary equipment, limiting computer bugs and finding smart solutions to substitute human presence and stimulate interactions (for example through forums, interactive chat, helpdesk...).

As a result, companies that offer e-learning to their employees must create an environment where such training will be recognized, appreciated and valued. This must be reflected in corporate policies, which must encourage the use of e-learning, and in getting all levels of the company onboard.

We have also seen that the courses must be adapted to the role of employees in the company. Indeed, an engineer, a designer or a salesperson will not be concerned by the same topics, will have to deal with different issues and will not use the same tools or the same language.

Finally, it should be remembered that improvements to the e-learning system go hand in hand with technological progress. As history has shown many times in the relationship between man and technology, there will most certainly be a major technological breakthrough in the years to come that will open new doors to e-learning and unlock an unsuspected potential to bring e-learning into a new phase.

## 9. Deliverables

### 9.1 Internal course

This course has been designed to be integrated into SharePLM's overall strategy. It is designed for SharePLM's client companies (specifically managers, HRD...), the goal is to make them aware of some essential elements to keep e-learning alive and increase user adoption.

The course was created with the e-learning solution Articulate 360 from the American company Articulate Global Inc. Founded in 2002, this company has reached more than 78'000 organizations in over 150 countries and claims to have reached 83 million learners (Articulate 2020). We naturally chose this tool since SharePLM uses Articulate to create most of its courses.

Articulate 360 offers different tools for developing e-learning courses, to create ours we used Rise 360. This is an application that allows creating e-learning courses and training directly from a simple web browser. It offers numerous "templates", especially for the microlearning method, and integrates many possibilities for interaction with the learners: flashcards, audio/video insertion, interactive images, evaluation tools, etc.

#### 9.1.1 Content

For confidentiality reasons, the entire course is not included in our work. The course is divided into 3 chapters and 8 lessons as seen on the screenshots below.

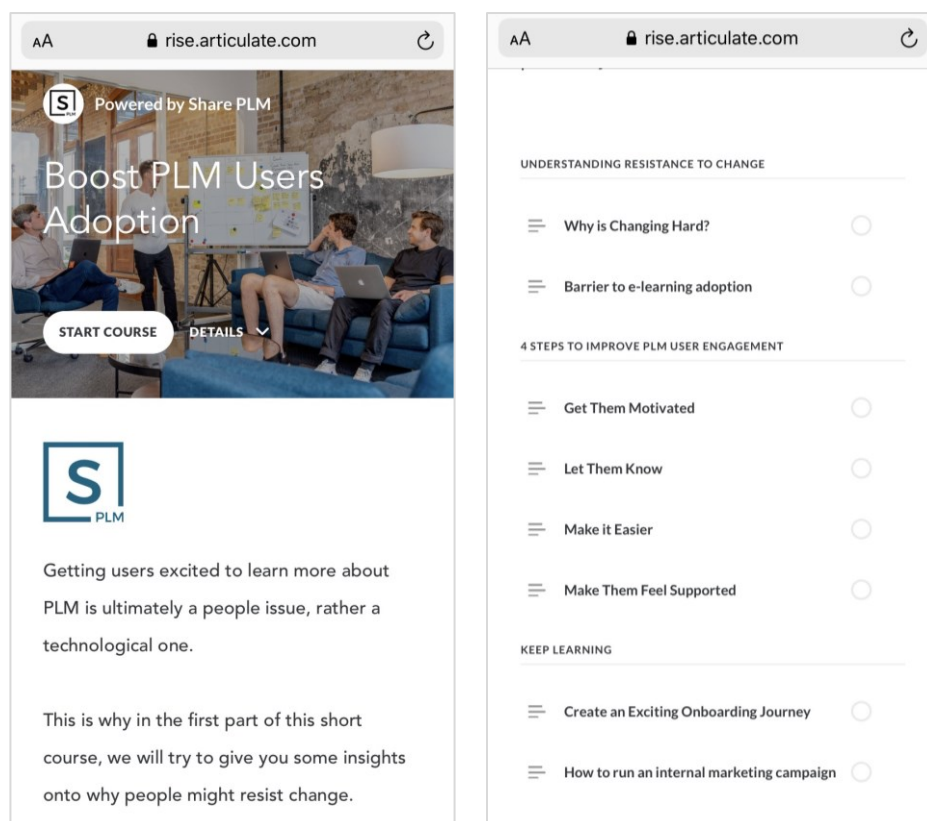


Figure 31: Screenshots of the home page and course content

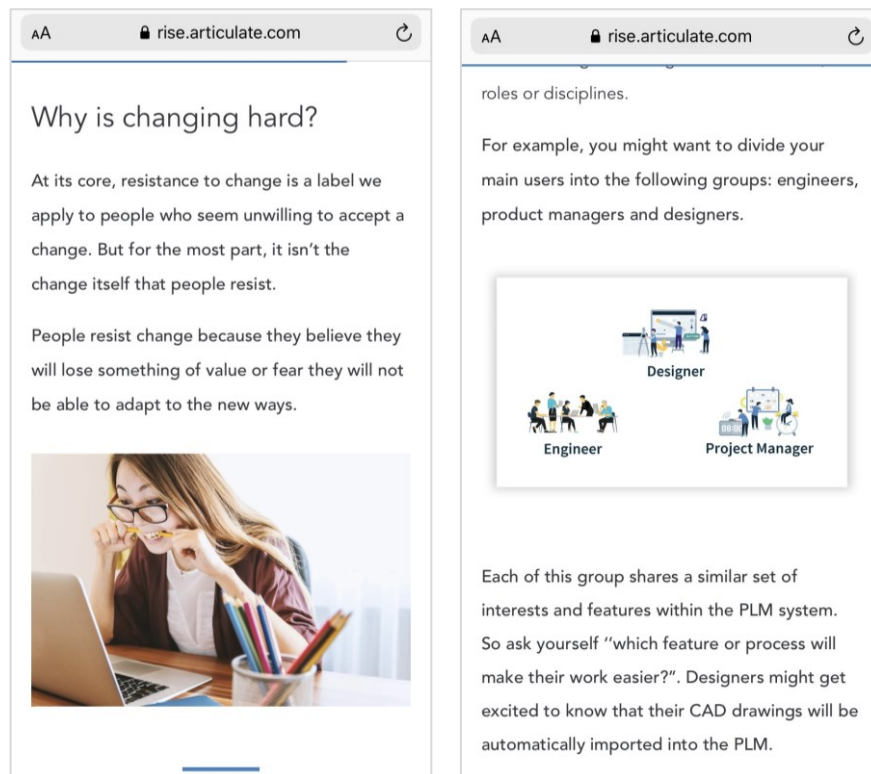


Figure 32: Example of the e-course

## 9.2 Post-course survey

A questionnaire template was also created to enable SharePLM to collect data after they deliver their courses. Indeed, the company currently collects little or no qualitative information once their courses have been delivered to their clients. This questionnaire will allow them to get feedback from users in an effort of continuous improvement.

We used Google Forms to develop this questionnaire (which will later be distributed through another tool by SharePLM) and took inspiration from Kirkpatrick's Four-Level Training Evaluation Model. This model allows measuring the effectiveness of a course and contains 4 levels of evaluation (Legault [s.d.]):

1. Reaction: this level indicates the reactions and opinion of the learners;
2. Learning: it measures whether learners have gained new attitudes, knowledge and skills;
3. Behavior: this determines if learners could apply what they just learned into daily tasks;
4. Results: the last level provides information regarding if the business objectives have been met through the training.

Our post-course survey is divided into the following 5 categories: course content, course expectations, timing, overall experience and socio-demographic issues. It is available in the appendix.

### **9.3 Blog post**

We also wrote an article based on some of the findings from this work. The blog post explains what is a PLM system. The article is included in the annex of this work. However, it does not have its final layout, as SharePLM has not yet published it on its blog. References and links will be included at the time of publication.

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# Appendix 1: Survey form

## Evaluating training programs: a survey made by SharePLM

The purpose of this survey is to understand your experience with e-learning in order to improve SharePLM's services. Your answers, comments and suggestions are valuable to SharePLM and they will help us to plan future programs that meet your needs and interests.

Please, feel free to give your honest opinion as this survey is anonymous. All the questions will be analysed by SharePLM. Any personal information will be kept strictly confidential and anonymized.

If you answer this survey you agree that the information collected will be used by SharePLM for statistical purpose. It will also be used for a Master thesis at the Haute école de gestion in Geneva, Switzerland. This thesis investigates e-learning practices and user's adoption for companies using PLM systems. Your anonymized data might also be used for future research.

This survey will take less than 10 minutes to complete. Should you have any questions or comments, please contact Myriam Jenni: [redacted] or Lena Nyffenegger: [redacted].

Your participation is very important and we thank you for the time you will take to complete these questions.

[Passer à la question 1](#)[Passer à la question 1](#)

### E-learning

1. Have you already taken an e-course offered within your company?

*Une seule réponse possible.*

- ☐ Yes [Passer à la question 2](#)  
☐ No [Passer à la question 24](#)

### E-learning course

2. In the past 12 months, how many e-courses have you taken?

*Une seule réponse possible.*

- ☐ 0  
☐ 1  
☐ Between 2 and 5  
☐ More than 5

3. When did you take the last e-course?

*Une seule réponse possible.*

- ☐ This week  
☐ This month  
☐ More than 3 months ago  
☐ More than 1 year ago

4. Let's focus on this last e-course, what was it about?

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5. How relevant was the subject(s) to your needs and interests?

*Une seule réponse possible.*

	1	2	3	4	5	
Poor	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Excellent

6. Why did you take this e-learning course?

(Multiple choice)

*Plusieurs réponses possibles.*

- ☐ By obligation (e.g. one of my superiors asked me to)
- ☐ By necessity (e.g. to acquire essential knowledge for my job)
- ☐ Out of personal interest (e.g. to improve my knowledge)

Autre : ☐ \_\_\_\_\_

7. I felt motivated to take this e-course:

*Une seule réponse possible.*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

8. Where did you follow this e-course?

(Multiple choice)

*Plusieurs réponses possibles.*

- ☐ At work
- ☐ At home

Autre : ☐ \_\_\_\_\_

9. Did you take the e-course:

*Une seule réponse possible.*

- ☐ In one go
- ☐ In several times
- ☐ Autre : \_\_\_\_\_

10. The duration of the e-course was:

*Une seule réponse possible.*

	1	2	3	4	5	
Too long	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Too short

11. Did you complete the e-course?

*Une seule réponse possible.*

- ☐ Yes    *Passer à la question 12*
- ☐ No    *Passer à la question 13*

12. How much time did you take to complete the e-course?

*Une seule réponse possible.*

- ☐ 1 to 30 minutes
- ☐ 30 to 60 minutes
- ☐ 60 to 90 minutes
- ☐ More than 90 minutes

*Passer à la question 14*

13. Why didn't you complete the e-course?

*Une seule réponse possible.*

- ☐ Lack of time
- ☐ It wasn't interesting
- ☐ It didn't suit my needs
- ☐ Autre : \_\_\_\_\_

*Passer à la question 14*

14. Did you have a follow-up after taking the e-course? (with a manager for example)

*Une seule réponse possible.*

- ☐ Yes  
☐ No  
☐ I don't remember

#### Perceived impact

15. The material covered in the e-learning course was relevant to my job:

*Une seule réponse possible.*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

16. I learned new skills / tools / concepts during this e-course:

*Une seule réponse possible.*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

17. After the e-learning, I was able to put into practice the skills / tools / concepts seen during the e-course:

*Une seule réponse possible.*

- ☐ Yes, right after the e-course  
☐ Yes, but long time after the e-course  
☐ No  
☐ Autre : \_\_\_\_\_

18. I feel that the e-learning course has enabled me to do my job better:

*Une seule réponse possible.*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

#### Satisfaction and general impression

19. Overall, I was satisfied with this e-course:

*Une seule réponse possible.*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

20. Did you recommend the e-course to other colleagues?

*Une seule réponse possible.*

☐ Yes

☐ No

21. What did you like during this e-course?

(Multiple choice)

*Plusieurs réponses possibles.*

☐ Content quality (concepts were clear, well explained...)

☐ The content was meaningful and relevant for my job

☐ Interactivities throughout the course

☐ Course design and user experience

☐ Length / Duration

☐ Hands-on exercises

☐ Access to support (material, key contact ...)

☐ Flexibility / self-paced

Autre : ☐ \_\_\_\_\_

22. According to you, what was the weakest part of the e-course and how could it be improved?

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23. Do you intend to take another e-course?

*Une seule réponse possible.*

☐ Yes

☐ No

☐ Maybe

☐ Autre : \_\_\_\_\_

*Passer à la question 26*

### Never taken an e-course

24. Why have you never taken an e-learning course offered by your company?

(Multiple choice)

*Plusieurs réponses possibles.*

- ☐ I don't have time
- ☐ I don't think it would be useful for me
- ☐ My company doesn't offer e-learning courses
- ☐ I don't know where to find these e-courses

Autre : ☐ \_\_\_\_\_

25. Do you intend to take an e-course in the future?

*Une seule réponse possible.*

- ☐ Yes
- ☐ No
- ☐ Maybe
- ☐ Autre : \_\_\_\_\_

*Passer à la question 34*

### E-learning in your company

26. Management encourages us to take e-learning courses:

*Une seule réponse possible.*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

27. How does your company communicate about e-learning ?

(Multiple choice)

*Plusieurs réponses possibles.*

- ☐ Internal advertising (on screen, flyers...)
- ☐ Newsletter
- ☐ E-mails sent by HR, management etc.
- ☐ Dedicated platform or website
- ☐ Team meeting
- ☐ My company doesn't communicate about e-learning

Autre : ☐ \_\_\_\_\_

28. Some e-learning courses are mandatory:

*Une seule réponse possible.*

- ☐ Yes
- ☐ No
- ☐ I don't know
- ☐ Autre : \_\_\_\_\_

29. Does your management give you time to follow e-learning courses during your working hours?

*Une seule réponse possible.*

- ☐ Yes    *Passer à la question 30*
- ☐ No    *Passer à la question 31*
- ☐ I don't know    *Passer à la question 31*

30. How much time do you have?

*Une seule réponse possible.*

- ☐ About 1-2 hours / week
- ☐ About 1-2 hours / month
- ☐ About 1-2 days / month
- ☐ About 1-2 days / year
- ☐ About 1-2 weeks / year
- ☐ I don't know
- ☐ Autre : \_\_\_\_\_

31. Do you feel you have access to appropriate support during e-courses? (person, ressource center, help desk...)

*Une seule réponse possible.*

- ☐ Yes
- ☐ No
- ☐ Autre : \_\_\_\_\_

32. Is there a platform (or other) that allows you to exchange knowledge with your colleagues?

*Une seule réponse possible.*

- ☐ Yes
- ☐ No
- ☐ Autre : \_\_\_\_\_



33. What are your suggestions to improve the e-learning programs in your company

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#### E-learning at work (in general)

34. How much time are you willing to devote to e-learning courses at work?

*Une seule réponse possible.*

- ☐ About 1-2 hours / week
- ☐ About 1-2 hours / month
- ☐ About 1-2 days / month
- ☐ About 1-2 days / year
- ☐ About 1-2 weeks / year
- ☐ Autre : \_\_\_\_\_

35. I would be more motivated to take an e-course if it is enforced:

*Une seule réponse possible.*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

36. I would find it beneficial to have a platform that allows me to exchange knowledge with my colleagues:

*Une seule réponse possible.*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

37. What do you think of support before, during and after training?

(Examples of support: e-tutoring or e-coaching, feedback, collaboration among learners...)

*Une seule réponse possible.*

- ☐ It is helpful
- ☐ I don't think it's necessary
- ☐ Autre : \_\_\_\_\_

38. It would be easier for me to take an e-course divided into smaller parts:

*Une seule réponse possible.*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

39. The duration of an e-course would have an impact on my motivation to take it:

*Une seule réponse possible.*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

40. Usually, do you prefer learning by:

(Multiple choice)

*Plusieurs réponses possibles.*

- ☐ watching videos
- ☐ reading explanation
- ☐ graphical representation of concepts
- ☐ listening to an audio explanation
- ☐ practical exercises/application
- ☐ a mix of all

Autre : ☐ \_\_\_\_\_

41. I would be enthusiastic about taking an e-course that incorporates gamification:

(Gamification is the application of game-design elements and game principles to improve learning.)

*Une seule réponse possible.*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

42. If you have any other comments, suggestions or things you would like to share with us, please do

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## Socio-demographic issues

43. Your gender

*Une seule réponse possible.*

☐ Male

☐ Female

44. Your age

*Une seule réponse possible.*

☐ 18 – 24

☐ 25 – 34

☐ 35 – 49

☐ 50 – 64

☐ 65 and older

45. What is the name or activity area of your company?

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46. What is the size of your company?

*Une seule réponse possible.*

☐ 1 to 9 employees

☐ 10 to 49 employees

☐ 50 to 249 employees

☐ 250 to 4'999 employees

☐ more than 5'000 employees

☐ Autre : \_\_\_\_\_

47. How long have you been working for this company?

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48. What is your role?

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Thank you for completing our survey!

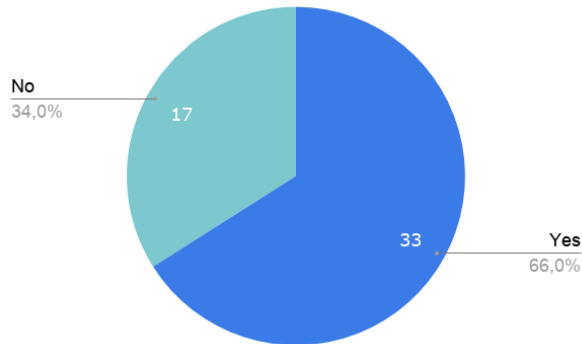
We are extremely grateful for the time you have taken to answer our questions. We truly value the information you have provided. Your responses will contribute to improving our e-learning programs.

If you have any comments or questions, please contact Myriam Jenni :

or Lena Nyffenegger :

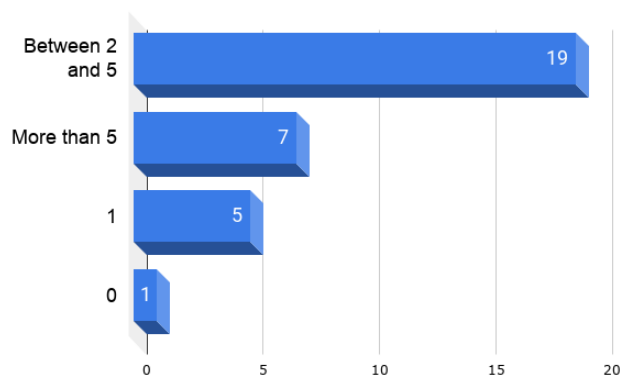
## Appendix 2: Survey results

1. Have you already taken an e-course offered within your company? *(If no, go to question 24)*

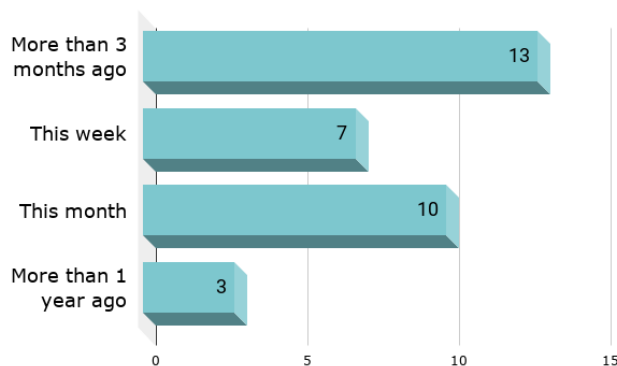


### E-learning course :

2. In the past 12 months, how many e-courses have you taken?



3. When did you take the last e-course?

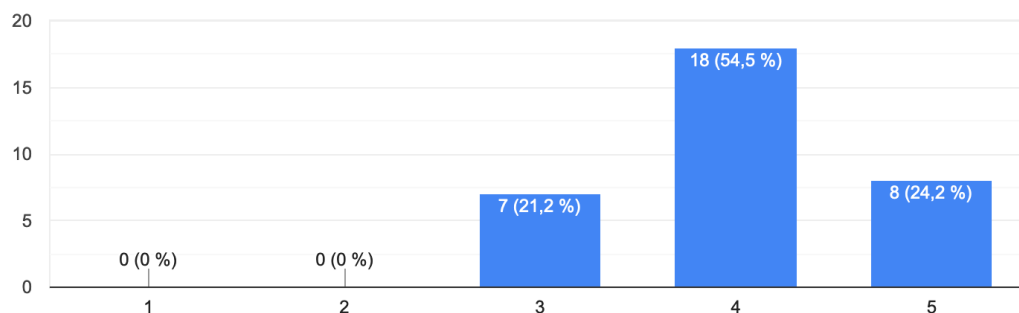


#### 4. Let's focus on this last e-course, what was it about?

1.	AI and Machine Learning	16.	Introduction to Python (coding)
2.	Asking for time off within the company	17.	IT security
3.	Banking mesures	18.	La présentation des différentes business line de l'entreprise dans laquelle je travaille
4.	Business Analysis	19.	Lean
5.	Change Management	20.	Lean methodology
6.	Cloud	21.	Learn about using a 3D program to make digital pattern of garments
7.	Coding	22.	Marketing
8.	Compliance	23.	MBE
9.	Cyber security	24.	PLM tools
10.	Digital Transformation	25.	Product information
11.	e commerce	26.	Protecting company's data
12.	Excel	27.	Public speaking
13.	Gestão Ágil (Scrum)	28.	Teamcenter
14.	Industry 4.0 and PLM	29.	Value Model
15.	Intellectual property	30.	Web security (compulsory training)

#### 5. How relevant was the subject(s) to your needs and interests?

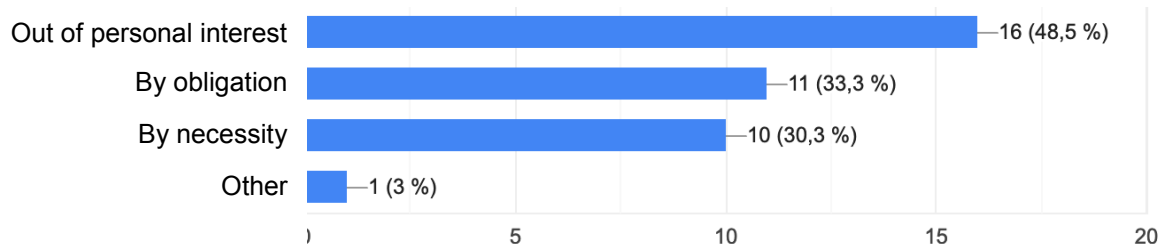
(1= poor / 2= fair / 3=average / 4= good / 5 = excellent)



#### 6. Why did you take this e-learning course?

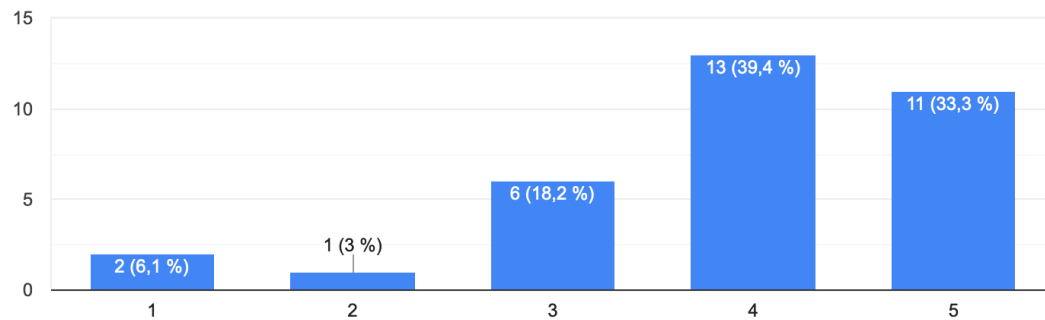
Other answer:

- «Evaluating training materials»



7. I felt motivated to take this e-course:

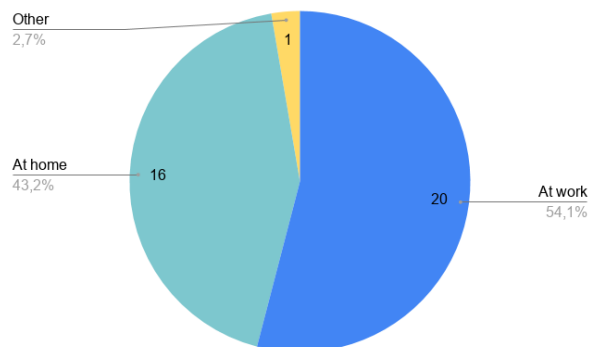
(1 = *strongly disagree* / 2 = *disagree* / 3 = *neutral* / 4 = *agree* / 5 = *strongly agree*)



8. Where did you follow this e-course?

Other answer:

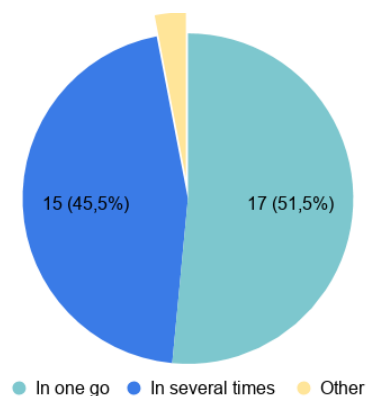
- «I work remotely from home.»



9. Did you take the e-course:

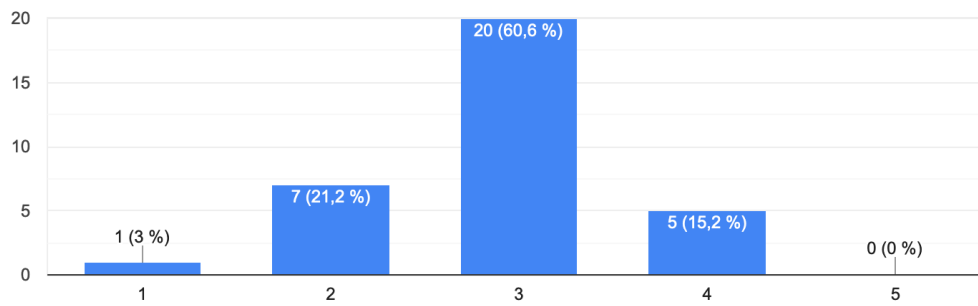
Other answer:

- «In 2 time half a day (it was more like an introduction course)»

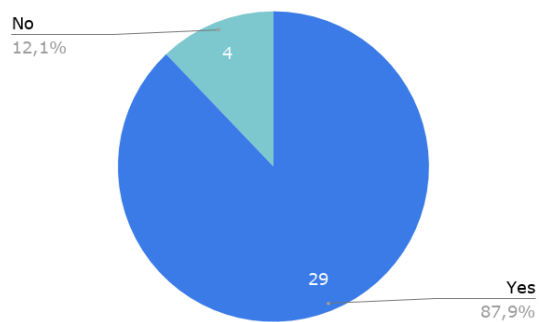


10. The duration of the e-course was:

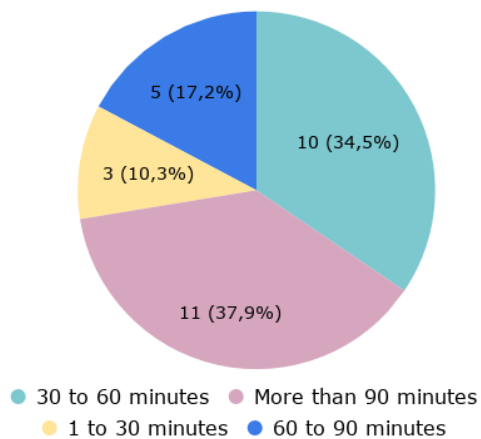
( 1 = too long / 2 = long / 3 = neutral / 4 = short / 5 = too short)



11. Did you complete the e-course? (if yes, go to question 12. If no, go to question 13)



12. How much time did you take to complete the e-course?

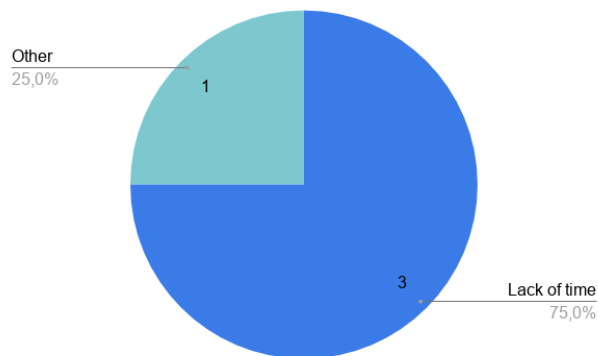




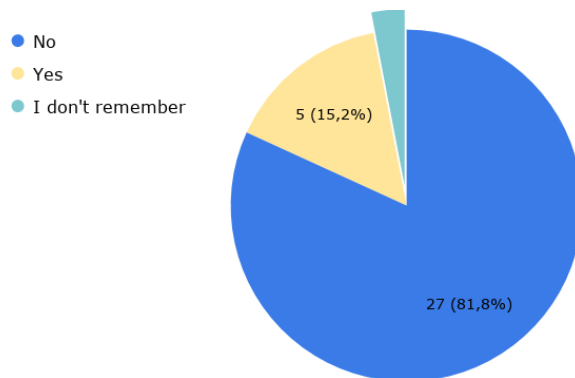
### 13. Why didn't you complete the e-course?

#### Other answer:

- «Quiz was 100% pass only, had to take a 15 min lesson again»



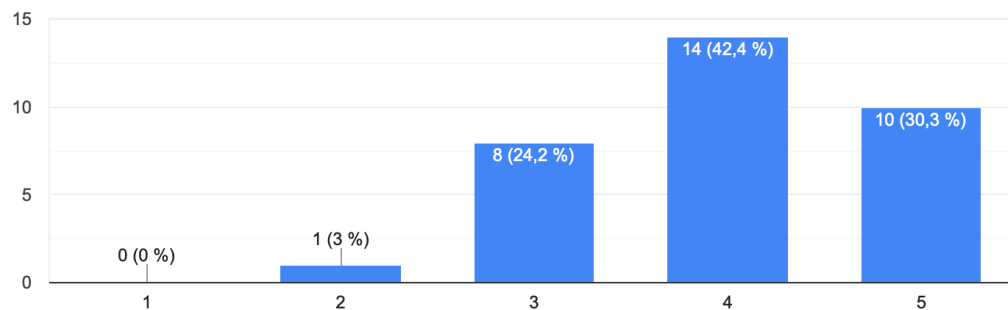
### 14. Did you have a follow-up after taking the e-course? (With a manager for example)



#### **Perceived impact :**

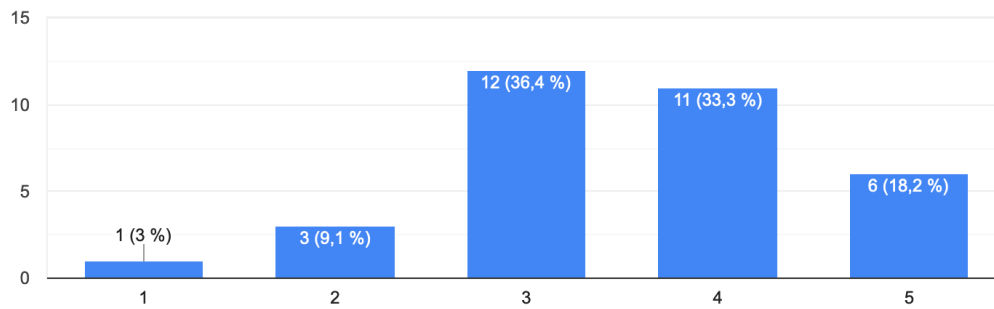
### 15. The material covered in the e-learning course was relevant to my job:

(1 = strongly disagree / 2 = disagree / 3 = neutral / 4 = agree / 5 = strongly agree)



16. I learned new skills / tools / concepts during this e-course:

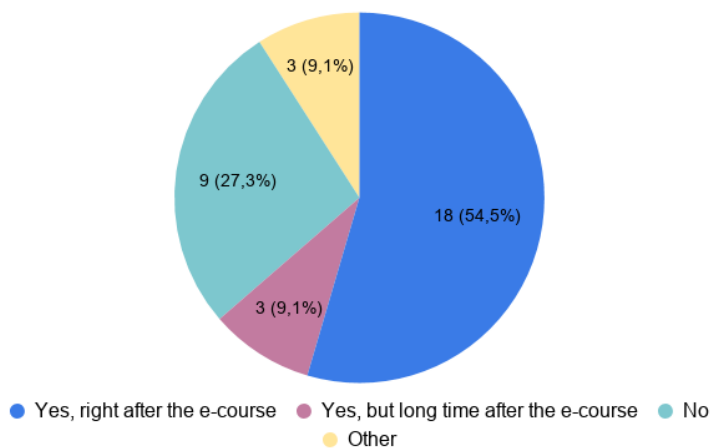
(1 = strongly disagree / 2 = disagree / 3 = neutral / 4 = agree / 5 = strongly agree)



17. After the e-learning, I was able to put into practice the skills / tools / concepts seen during the e-course:

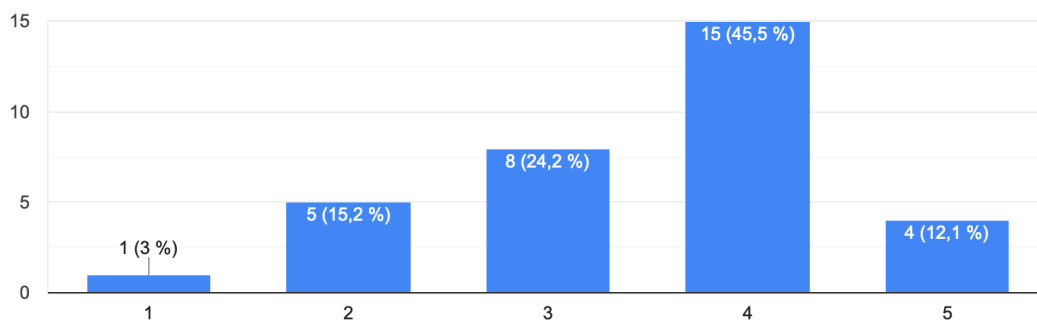
Other answers:

- «I already knew those things»
- «Global knowledge»
- «We took the e-course to evaluate if we want to implement the program in our company. So we might use it soon.»



18. I feel that the e-learning course has enabled me to do my job better:

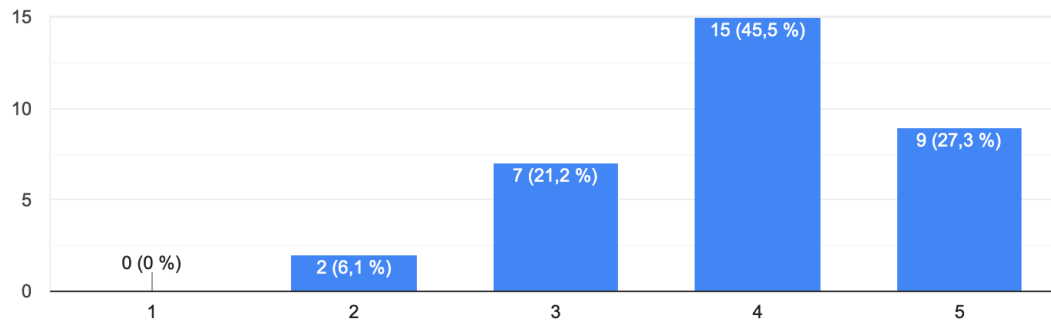
(1 = strongly disagree / 2 = disagree / 3 = neutral / 4 = agree / 5 = strongly agree)



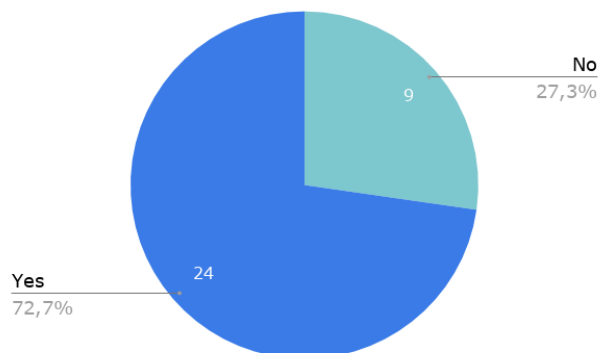
## Satisfaction and general impression:

19. Overall, I was satisfied with this e-course:

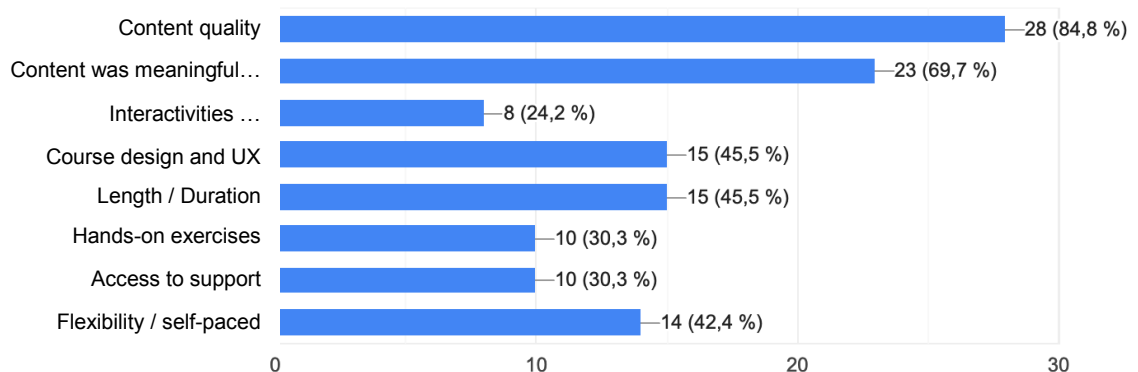
(1 = *strongly disagree* / 2 = *disagree* / 3 = *neutral* / 4 = *agree* / 5 = *strongly agree*)



20. Did you recommend the e-course to other colleagues?



21. What did you like during this e-course?



22. According to you, what was the weakest part of the e-course and how could it be improved?

Maybe a bit more interaction. Be able to have access to the program in between the 2 courses (that was one week apart) to experiment, try and come up with more questions on the next course.

More focus on Theories

The exercises. Detail questions where all questions needed fully right answers and everything had to be memorized. Third time took screen capture of each pic to pass. Shit.

interactivity and balance between hands-on and theory can be improved

Lack of interaction with other learners

Les vidéos explicatives n'étaient pas de très bonne qualité

(Nothing)

Less Exercises

To long

No interactions with a specialist in real time, I had to take a few notes on specific topics to ask the contact given after the elearning

some of the quizzes could be improved - too much detail questions not relevant for understanding the bigger picture

cost was high

Should be orgainzed for different experience levels so you could eg jump the basic stuff if you already were familiar with it

Lack of wrap up. After 45 minutes, there wasn't a litte conclusion about important points of this session.

length

Sometimes, it is not specific enough.

maybe a lack of reminder to keep going until the end

Too short timeframe to finished the course

Practice, more exercises needed

Much of the course was things that I already know about

Forcing you to wait before going to the next slide

Subject

No clue

Partly the speed was too slow. Maybe because a portion of the scope was already familiar for me.

examples were food and hardware. in software sales there are specifics about the customer journey

It was a bit repetitive throughout the course.

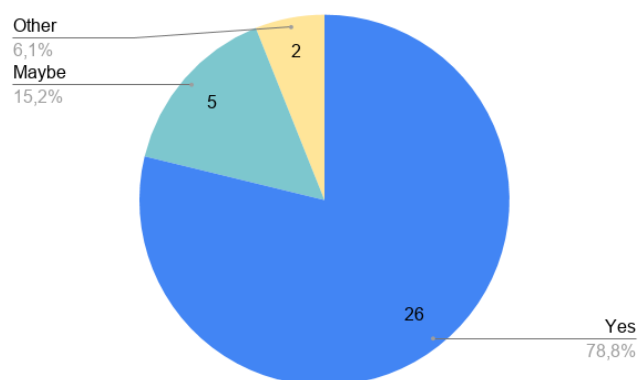
It was promoting a specific product/service

I have to take this course each year, content is stale

### 23. Do you intend to take another e-course?

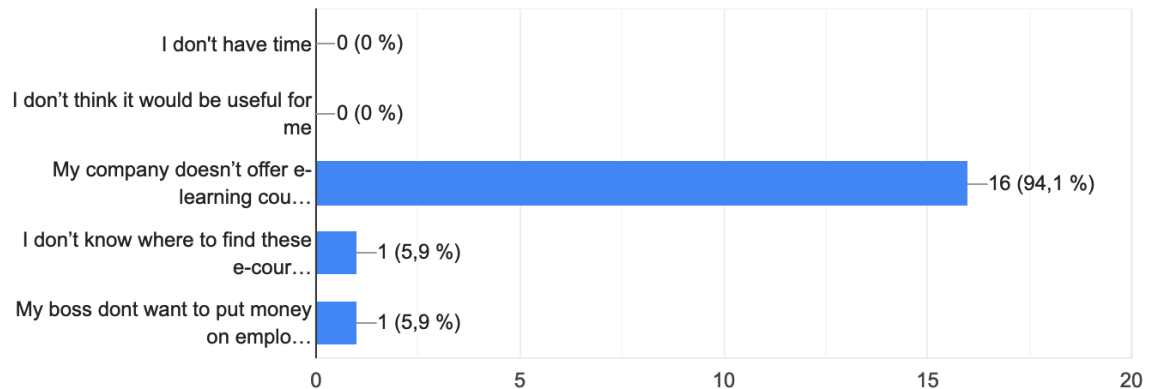
#### Other answer :

- *«I am also going through an online EMBA, based mainly on e-course»*
- *«if required»*

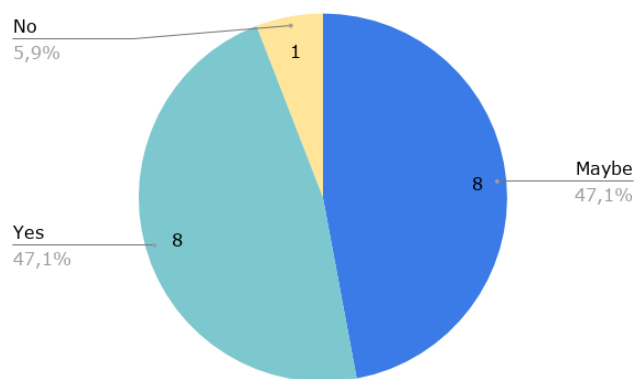


## Never taken an e-course:

24. Why have you never taken an e-learning course offered by your company?



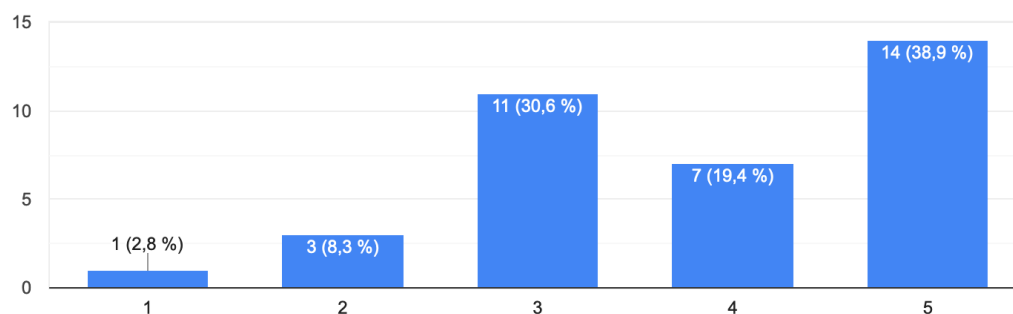
25. Do you intend to take an e-course in the future? (Then go to question 34)



## E-learning in your company:

26. Management encourages us to take e-learning courses:

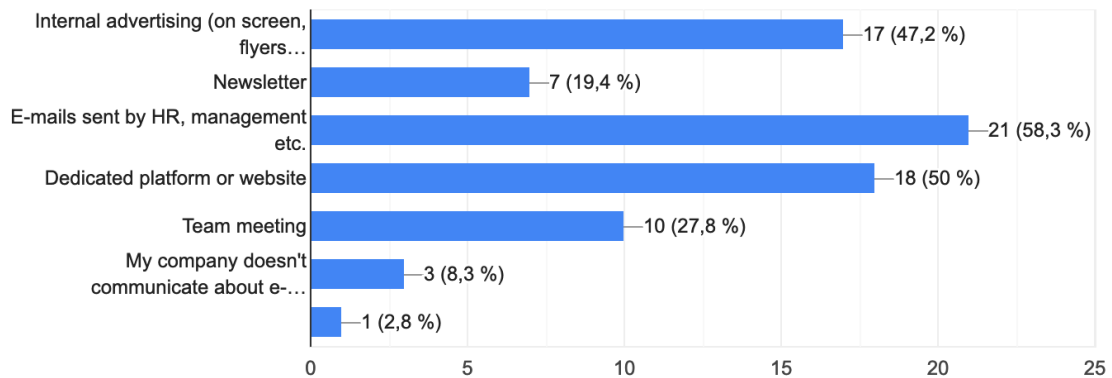
(1 = strongly disagree / 2 = disagree / 3 = neutral / 4 = agree / 5 = strongly agree)



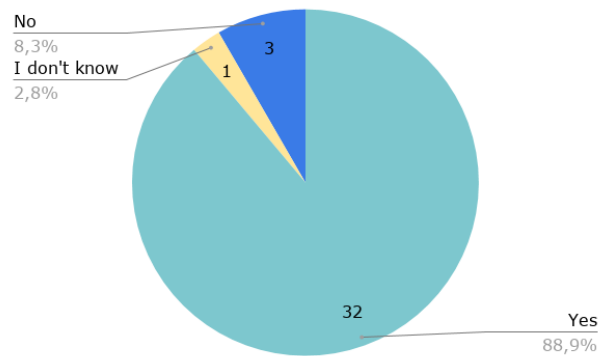
## 27. How does your company communicate about e-learning?

One answer :

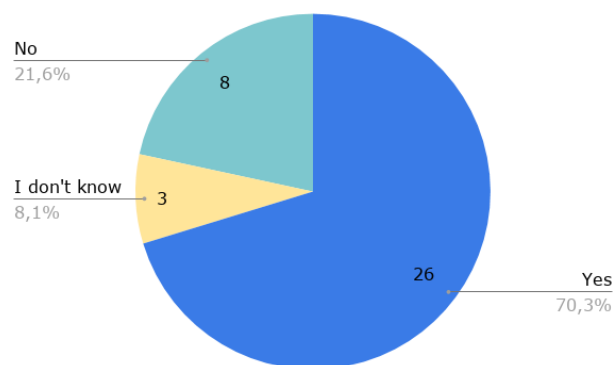
- «We have dedicated forums where different colleagues can share their experience and recommendations»



## 28. Some e-learning courses are mandatory:



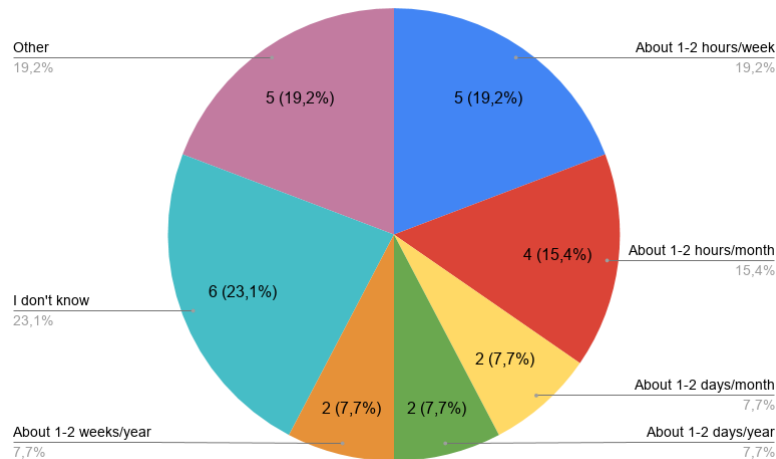
## 29. Does your management give you time to follow e-learning courses during your working hours? (If yes go to question 30. If no or I don't know, go to question 31)



### 30. How much time do you have?

#### Other answers:

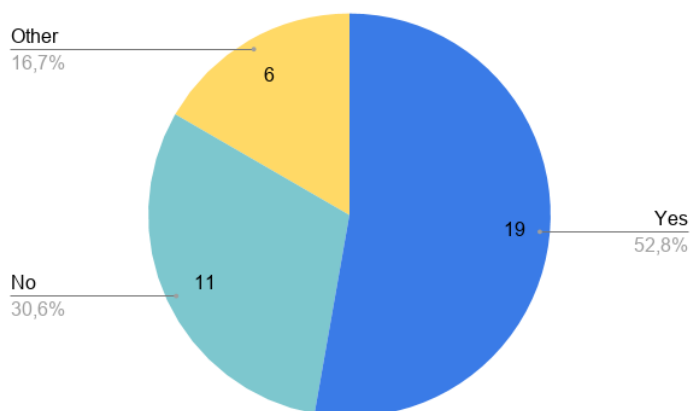
- «Depending on the needs, but couples of certifications are parts of the yearly objectives for each employee.»
- «Just a few hours for new employees»
- «The time needed for the mandatory (we use timesheet with special codes ) and then if it's approved we can also do them at work and use a timesheet code»
- «3-5 hours / week»
- «as needed»



### 31. Do you feel you have access to appropriate support during e-courses? (Person, ressource center, help desk...)

#### Other answers:

- « Yes (radio button doesn't work?)»
- « N.A »
- « Je ne sais pas, cela fait trop peu de temps que je travaille dans cette entreprise »
- « Most of the time yes, but if there is a really specific question we have to ask outside of the e-learning »
- « Not have trained yet »
- « Not needed »

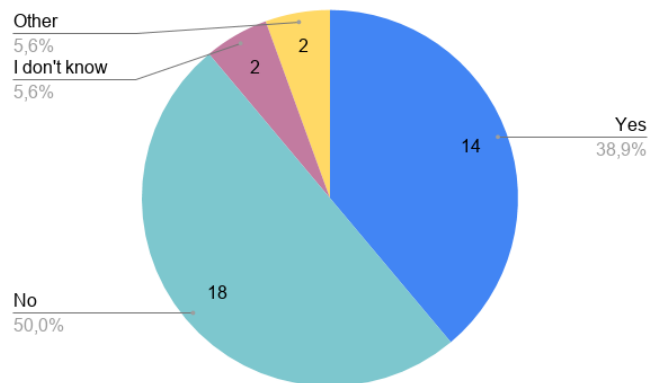




32. Is there a platform (or other) that allows you to exchange knowledge with your colleagues?

Other answers :

- « *Kind of but need a more flexible metatagged Knowledge base.* »
- « *Online communities* »



33. What are your suggestions to improve the e-learning programs in your company?

make it fun, useful and practical

More content in French (everything is in English) and offer blended learning and gamification to make it more appealing and playful

Je n'ai malheureusement pas assez de recul pour le dire malheureusement.

Nothing particular

Make it more user-friendly

A better introduction to the e-course explaining its benefits and why it is mandatory. Also inform about the length as you want to plan it in your agenda

Exercises better scaled to measure learning, not memorizing.

access to the various curricula and certifications.

Plataforma de compartilhamento de conhecimento entre colegas e outras companhias (organizações)

Online support

subscribe to e-learning / presentations stream

None

All E-learning's should have an audio!

-

Focus on fact inside the business cases

Simplified plateformes

Implement mandarory e-learning program

I had only one and it was during the covid. I think otherwise we mostly do it physically. But I would love to have more e-learning. Have a platform where I can subscribe to course provided by my company that can improve my daily work.

Animated, simple but specific and short

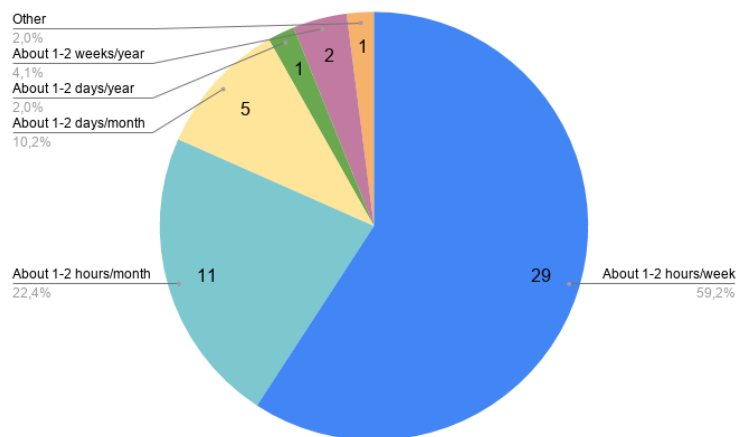
NA

### E-learning at work (in general):

34. How much time are you willing to devote to e-learning courses at work?

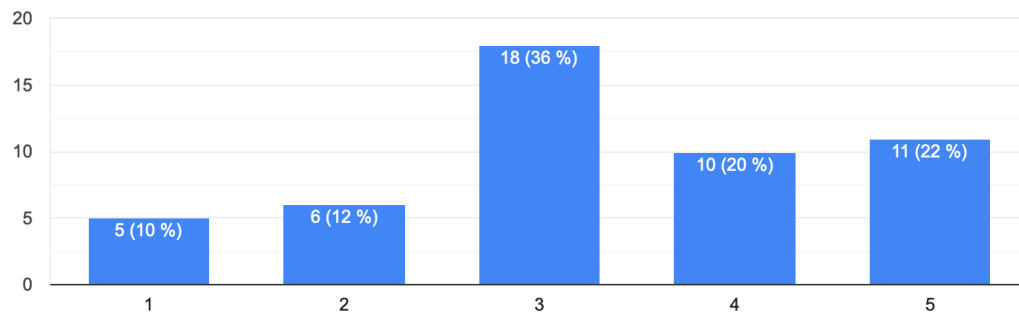
Other answer :

- «As needed and allows by the ongoing projects.»



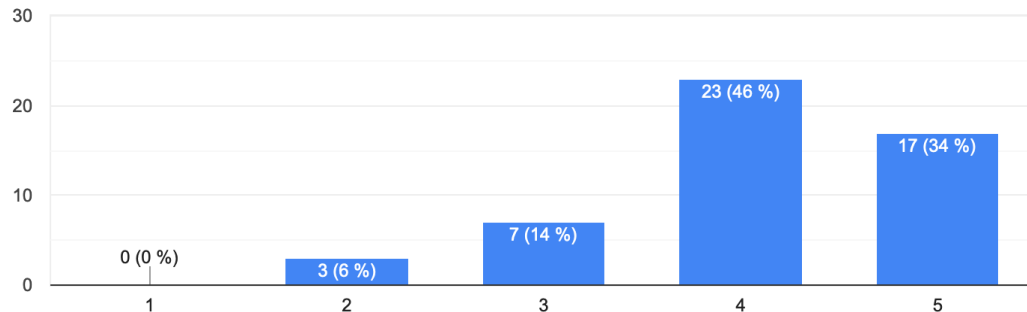
35. I would be more motivated to take an e-course if it is enforced?

(1 = strongly disagree / 2 = disagree / 3 = neutral / 4 = agree / 5 = strongly agree)



36. I would find it beneficial to have a platform that allows me to exchange knowledge with my colleagues:

(1 = strongly disagree / 2 = disagree / 3 = neutral / 4 = agree / 5 = strongly agree)

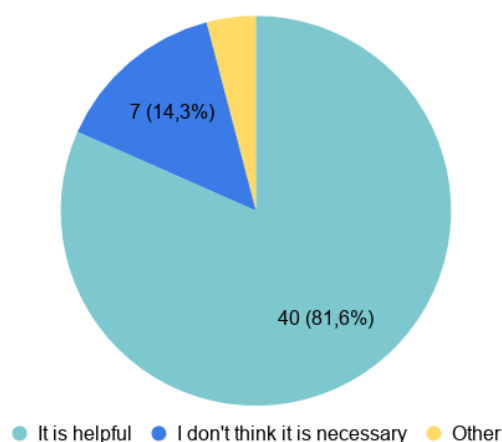


37. What do you think of support before, during and after training?

(Examples of support: e-tutoring or e-coaching, feedback, collaboration among learners...)

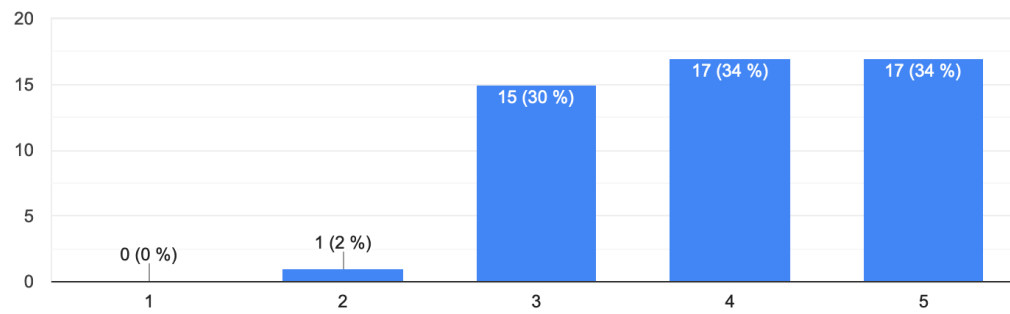
Other answers :

- «Je ne sais pas, cela fait trop peu de temps que je travaille dans cette entreprise.»
- «Not helpful for me but might be for others.»



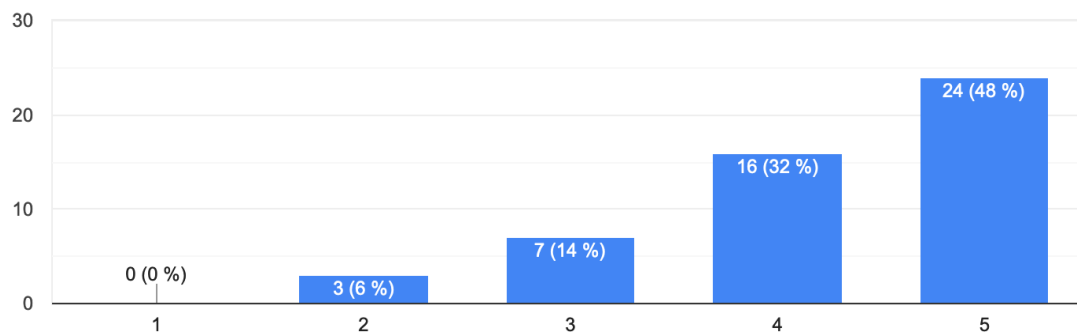
38. It would be easier for me to take an e-course divided into smaller parts:

(1 = *strongly disagree* / 2 = *disagree* / 3 = *neutral* / 4 = *agree* / 5 = *strongly agree*)

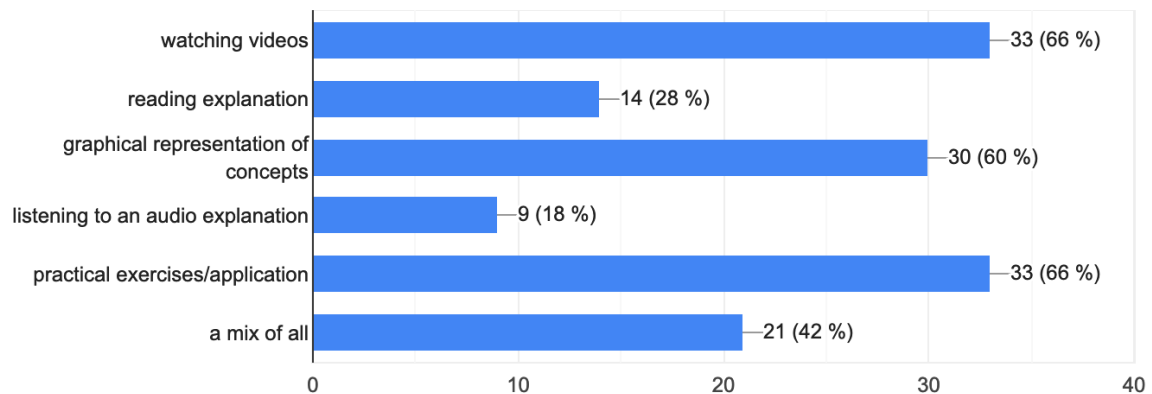


39. The duration of an e-course would have an impact on my motivation to take it:

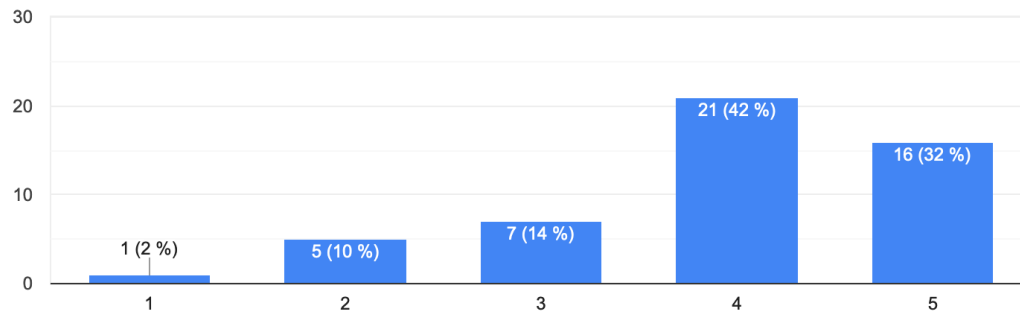
(1 = *strongly disagree* / 2 = *disagree* / 3 = *neutral* / 4 = *agree* / 5 = *strongly agree*)



40. Usually, do you prefer learning by:



41. I would be enthusiastic about taking an e-course that incorporates gamification:



42. If you have any other comments, suggestions or things you would like to share with us, please do.

knowledge sharing is important, but the way to share and learn is the key. e-Learning provides the flexibility as long as the content, and the way it is shared is entertaining.

E-learning is good but you always need a human interaction with it. It cannot completely replace teaching in my opinion as you want to ask questions, share understanding, resume key concepts, etc.

no comment

Я думаю, что игровой офис - это будущее обучения!

The questions are incredibly bad, it is impossible to answer them accurately

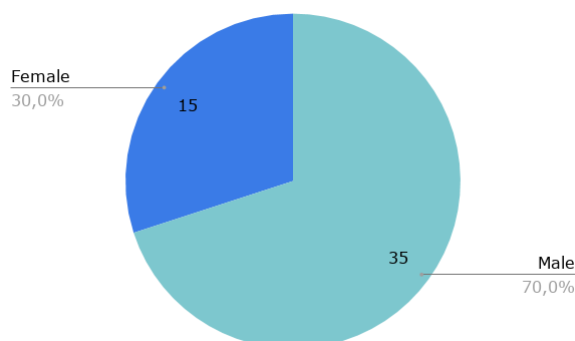
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Planning for own business development if you want to join me please mail me [sudamrupnar@gmail.com](mailto:sudamrupnar@gmail.com)

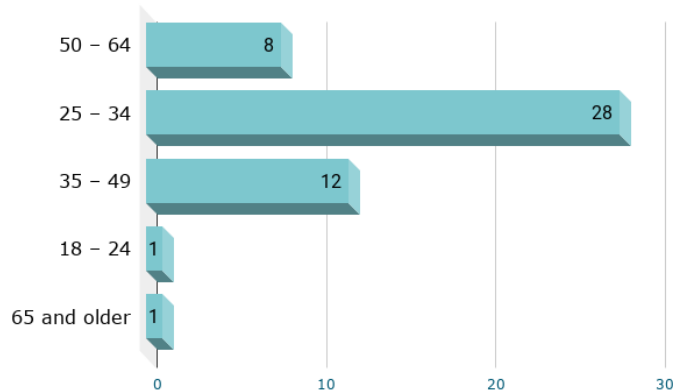
gamification is not fun if it is not a serious game with winners

### Socio-demographic issues:

43. Your gender:



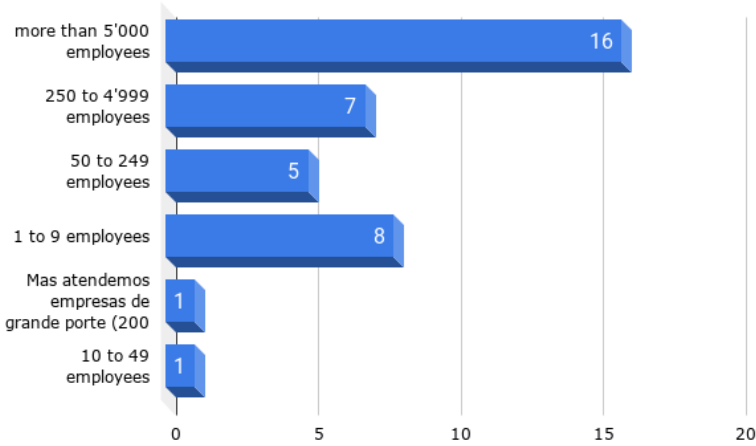
#### 44. Your age:



#### 45. What is the name or activity area of your company?

Related to PLM		Other ...	
1	Aerospace	1	A Bank
2	Dassault Systèmes	2	Advisor
3	Electrolux	3	App tech
4	Everis NTT DATA	4	Banque Pictet
5	Fashion industry (clothing)	5	Business Intelligence
6	Freelance / PLM consultant	6	Clarins S.A
7	Fujitsu Consulting India Private Limited	7	Configuration Management
8	Ganister	8	Consulting in Digital, Technology, Engineering
9	Google	9	Digital Marketing
10	IT services PLM	10	Ernst & Youngs
11	IT System Engineer, Windchill Business and System Administrator	11	Etat de Genève
12	Philip Morris Intl.	12	Finance / IT
13	PLM (1)	13	Furniture (RGE Trading)
14	PLM (2)	14	Import & Trading
15	PLM (3)	15	Mass media
16	PLM (4)	16	OFAC
17	PLM (5)	17	PPS Consultoria e Projetos (Consultoria)
18	PLM Administrator	18	Real Estate
19	PLM and Engineering platforms	19	Retail business
20	Share PLM	20	Technology
21	Siemens digital industry partner		
22	Tata Consultancy Services		
23	Technia		
24	Watch making		

46. What is the size of your company?



## Appendix 3: Post-course survey

### Post-course evaluation

The purpose of this survey is to understand your experience with e-learning in order to improve SharePLM's services. Your answers, comments and suggestions are valuable to SharePLM and they will help us to plan future programs that meet your needs and interests.

This survey will take less than 10 minutes to complete. Should you have any questions or comments, please contact us: [XXX@shareplm.com](mailto:XXX@shareplm.com)

Your participation is very important and we thank you for the time you will take to complete these questions.

#### Course content

1. Did you find the course interactive?

*Une seule réponse possible.*

- ☐ Yes  
☐ No  
☐ Autre : \_\_\_\_\_

2. The course content (readings, exercices, videos, etc.) facilitated my learning.

*Une seule réponse possible.*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

3. How was the quality of the examples presented in the e-learning:

*Une seule réponse possible.*

	1	2	3	4	5	
Very bad	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very good



4. Above all, what did you like during this e-course?

(Multiple choice)

*Plusieurs réponses possibles.*

- ☐ Content quality (concepts were clear, well explained...)
- ☐ The content was meaningful and relevant for my job
- ☐ Interactivities throughout the course
- ☐ Course design and user experience
- ☐ Length / Duration
- ☐ Hands-on exercises
- ☐ Access to support (material, key contact ...)
- ☐ Flexibility / self-paced

Autre : ☐ \_\_\_\_\_

5. I managed to reach the course objectives

*Une seule réponse possible.*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

6. The course workload and requirements were appropriate for the course level

*Une seule réponse possible.*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

Course expectations

7. How relevant was the subject(s) to your needs and interests?

*Une seule réponse possible.*

	1	2	3	4	5	
Poor	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Excellent

8. I learned new skills / tools / concepts during this course:

*Une seule réponse possible.*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

9. After the e-learning, I was able to put into practice the skills / tools / concepts seen during the e-course:

*Une seule réponse possible.*

- ☐ Yes  
☐ No  
☐ Autre : \_\_\_\_\_

10. I feel that the e-learning course has enabled me to do my job better:

*Une seule réponse possible.*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

11. Are there any topics that haven't been covered that you would have liked to study?

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#### Timing

12. Did you take the course:

*Une seule réponse possible.*

- ☐ In one go  
☐ In several times  
☐ Autre : \_\_\_\_\_

13. How much time did you spend on this course?

*Exemple : 8 h 30*

---

14. The duration of the course was:

*Une seule réponse possible.*

	1	2	3	4	5	
Too long	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Too short

15. Did you complete this course?

*Une seule réponse possible.*

- ☐ Yes  
☐ No

#### Overall experience

16. Overall, I was satisfied with this e-course:

*Une seule réponse possible.*

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

17. Did you recommend the e-course to other colleagues?

*Une seule réponse possible.*

- ☐ Yes  
☐ No

18. According to you, what was the weakest part of the e-course?

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19. What are your suggestions to improve this e-learning course?

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20. If you have any other comments, suggestions or things you would like to share with us, please do

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Socio-  
demographic  
issues

Please remember that any personal information will be kept strictly confidential and anonymized.

21. Your gender

*Une seule réponse possible.*

- ☐ Male  
☐ Female

22. Your age

*Une seule réponse possible.*

- ☐ 18 – 24  
☐ 25 – 34  
☐ 35 – 49  
☐ 50 – 64  
☐ 65 and older

23. What is your role?

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## Appendix 4: Blog post

### What is a PLM System?

Defining Product Lifecycle Management (PLM) is a tricky task... the difficulty stems from its complexity and the fact that the term PLM can have several meanings.

On one hand, it's a business strategy. If we add the word system to PLM, then we are talking about a software solution. Ultimately, it can also represent an aspiration approach to how product should be developed.

In today's article, we are going to look at the second definition of PLM. The one that relates to systems.

However, to understand PLM softwares, we must first understand the strategy behind it. So let's look at a definition of PLM, as a business approach:

*« (...) PLM Product lifecycle management – is a strategic business approach that supports all the phases of product lifecycle, from concept to disposal, providing a unique and timed product data source. Integrating people, processes, and technologies and assuring information consistency, traceability, and long-term archiving, PLM enables organizations to collaborate within and across the extended enterprise. » (Corallo et al. 2003)*

Organizations decide to get on board of a PLM initiative because ultimately it has a strategic advantage. Indeed, a good management of the industrial products' lifecycle can allow a company to gain competitive advantages in a fast-paced environment: by reducing design costs, improving product quality, reducing time to market for a new product or speeding up innovation.

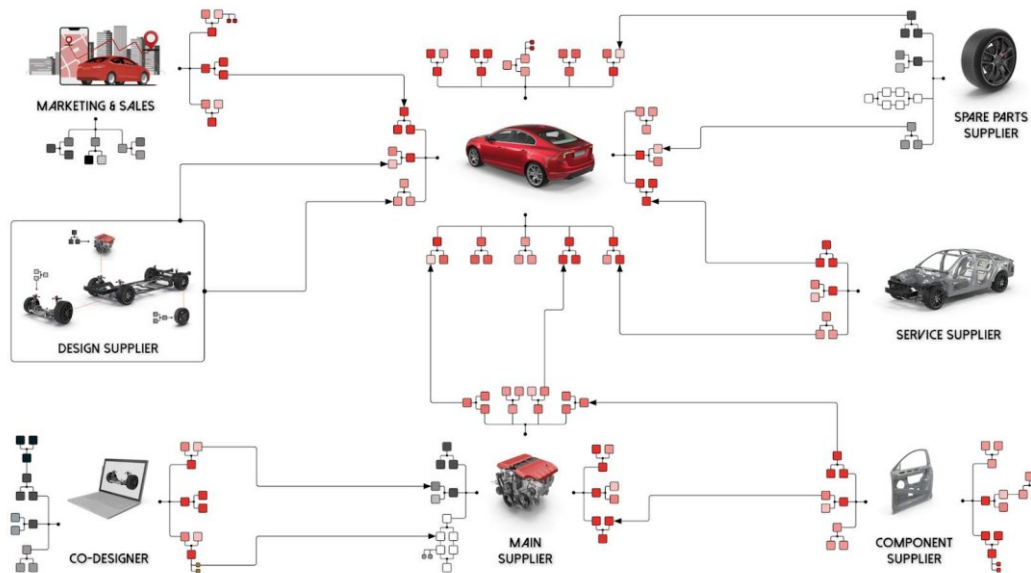
That sounds great, no? But how does an organization actually put that into practice? How does it manage to integrate people, processes and technology in order to become more competitive?

That's where the PLM system comes into the picture.

### So what is a PLM system?

A PLM system enables organizations to manage their products digitally —connecting all relevant product data through a central repository of information and creating a reliable digital thread. So everyone from the conceptual designer to the end-customer is on the same page, sharing the same up-to-date product definition.

In addition, a PLM software connects the different disciplines and allows companies working with large teams, suppliers and partners geographically dispersed to collaborate through smart products.



## A brief history of PLM System

In the 1980s, Computer-Aided Design (CAD) became more and more popular. However, CAD files were often large, and took a lot of computer memory space. It was a challenge for businesses to manage the burdensome number of CAD files necessary to complete a single project.

In response to this problem, Product Data Management (PDM) was developed to help manage CAD files. PDM used softwares to handle all the product-related information, including CAD data, manufacturing details, and other documents.

At this stage, the two key elements of PLM tools were already in place. It was the company Unigraphics that first thought of combining CAD and PDM together into a new system called Product Lifecycle Management (PLM).

In 1985, American Motors Corporation was looking for a way to be more competitive by developing their products more quickly so they began using a PLM system. The Jeep Grand Cherokee was the first car to be designed entirely with PLM tools. This set a precedent for PLM tools, and shortly after more organizations started using it.

In the year 2000, the first cloud-based PLM software was introduced by BOMControl. The market share of cloud-based PLM applications has been growing continuously for several years and is expected to represent 30% of the total PLM solutions market by 2024, a market of more than USD 4.16 billion, according to a study conducted by Quadrant Knowledge Solutions. (2019).

## A snapshot of the PLM System Market

The global product lifecycle management market size, including revenue data from PLM solution suppliers, systems integrators, and resellers in the PLM space, was valued at USD

47.8 billion in 2019 and is expected to expand over USD 60 billion by 2023 (Markets Insider 2020).

This market is constantly growing, in particular thanks to an ever increasing demand for PLM solutions for small and medium enterprises in various sectors. The main motivation of these companies is to optimize the manufacturing cost of their products. A market also stimulated by the digital transformation of certain industries and the widespread use of Industrial Internet of Things devices (Grand View Research 2020).

In the global market, automotive, industrial equipment, aerospace and defense and high technology are the main users of PLM. Leading PLM solution providers include Dassault Systèmes, PTC, Siemens, SAP. These companies develop and market PLM technology that enables them to manage complex processes associated with complex documents, products, projects and systems. They reach a wide variety of PLM use cases by offering complete technology solutions for innovation, design, product data management, simulation and digital manufacturing (Quadrant Knowledge Solutions 2019).

