

Article

# How Constructionist Perspectives on Learning Can Improve Learning and Prevent Accidents in High-Risk Industries

Thomas Wold 

Business School, Nord University, 7502 Stjørdal, Norway; thomas.wold@nord.no

**Abstract:** Management systems containing procedures, checklists, and descriptions for how various tasks should be conducted are often used in high-risk industries. Much has been written about the judicial and technological concerns of management systems, but less has been written on how to train staff in the use of them. Through a cognitive-constructionist perspective combined with social constructivism, this paper discusses how staff training can be designed to fit the characteristics of the workers. This paper focuses on how people learn in different ways, and how this is related to perspectives on knowledge. The method used is semi-structured interviews with twenty-seven workers in two different companies operating in the oil and gas-producing industry. The workers got only a short web-based theory course on the management system, with no practical exercises, repetitions, or other types of follow-ups. This is a signal that the management system is of less importance, and many of the workers thought they did not need it. Training must be designed to fit the workers, with practical exercises, repetition, and possibilities for on-the-job training. Accidents in this sector can cause human losses and great environmental harm, and this paper argues that better training of staff can prevent such accidents and reduce harm to the environment.

**Keywords:** management system; training; high-risk industry; cognitive constructionism; social constructivism; accident prevention



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## 1. Introduction

Management systems containing procedures, checklists, and descriptions for how various tasks should be conducted are often used in high-risk industries [1,2]. They are IT-based socio-technical systems whose purpose is to accumulate and share good knowledge and practices, meet the regulatory requirements, and avoid accidents that harm to the environment and the worker's health and safety [3–7]. They can be helpful for a geographically dispersed organization to make sure all necessary governing documentation is available to all staff members and is usually regarded as an integrated sub-system of the total organizational management [7,8].

Much has been written about the judicial and technological concerns about management systems, but less on how to train staff in the use of them [1]. According to the European Committee for Standardization training in the use of all forms of work systems stresses should be given priority [9]). Training is recognized as an important element for a safe workplace and a good working culture, and studies suggest a correlation between training, safety culture, and the use of management systems [2,10–12].

The gas and petroleum sector are a high-risk industry where accidents can cause human losses and severe environmental harm. Staff training can improve safety and organizational performance and reduce environmental harm by improving the staff members' cognitive and interpersonal skills [12–15]. For this to succeed one must know who the workers are; what are their abilities, their experience, and their motivation to learn, and design the training to fit the characteristics of the workers [16].

Through a cognitive-constructionist perspective combined with social constructivism, this paper will discuss how people learn [17,18], and how a training program can be

designed to fit the characteristics of the workers to secure a good learning and safety culture. This paper will focus on how people learn in different ways, and how this is related to perspectives on knowledge. The author of this paper conducted 27 interviews with workers in two different companies operating in the oil and gas-producing industry. The purpose of the interviews was to hear from their perspectives how they perceived the training they got and whether it helped them or not in using the management system. The paper will present the learning principles of cognitive constructivism and the importance of knowing the characteristics of the trainees and their motivation to learn. The paper will also go into the importance of identifying what the trainees need to learn to serve the requirements of the job, and how this can be achieved by using a combination of different training methods that all adhere to the central principles of active learning.

### *1.1. Definition of Training*

Training is systematic activities to improve the knowledge and skills of the trainee and to shape attitudes, whether it is theoretical instruction practical training, or a combination [18–20]. The purpose is to let the trainee practice the physical and mental skills needed to handle the various tasks and conditions in the job environment [21].

Education does not end at school but continues throughout the professional career. The research field on staff training is rich, with a wide variety of perspectives and topics, and generally shows that training helps to improve cognitive and interpersonal skills, and organizational performance, to improve cognitive and skills, should therefore be viewed as an investment in human capital [13,14,22]. Studies also show that lack of appropriate training predisposes workers to act unsafely [10,11,23].

### *1.2. Cognitive Constructionism*

The cognitive-constructionist perspective is useful here [17,18]. This learning theory focuses on mental processes when we receive and understand information. Learning always builds on the trainee's existing knowledge, so one needs to know what the trainee already knows [24]. An important aspect here is that external rewards are not the primary motivators for learning, but rather that learning and curious exploring is a reward in itself [25]. Humans have a natural curiosity and can therefore have an active role in the learning process, where they get to figure out stuff for themselves, rather than just being handed over information to memorize [18,25].

We don't literally store new information and experiences in a filing cabinet, but organize them to fit with our inner schemes in a process of assimilation [25]. Sometimes the inner schemes fail to explain the new information, and in such cases, the individual must reorganize and expand the schemes in a process called accommodation [25]. For this to happen the individual must have an inner motivation to seek new information when facing a challenge or problem [26].

Behaviorism differs from this perspective as it views learning as something that happens when associations between impulses and results are created, and that the result of learning can be measured [27]. This somewhat old-fashioned view of learning is still relevant in certain contexts. For instance, when a worker must pass a safety knowledge test to get legal permission to work on an offshore installation. Although this can be said to be a legal requirement more than a practical, it involves a replication of information that can somewhat be measured. Whether or not the trainee understands the information, or has merely memorized it, cannot be measured in the same way. Hence, behaviorism alone is not sufficient to understand learning in this context.

Cognitive constructionism shares some ideas with social constructivism. Both perspectives view humans as active participants in the creation of their knowledge, but the latter focuses more on the immediate context of the learning situation and stresses that activity and social interaction are essential for learning to happen [17,18,28]. Learning takes place in social and cultural settings, not just inside each individual, and the trainees learn through interaction with their peers [24]. This makes discussion an essential tool, since it

activates the individual trainee's experience, values, and interests, and allows him or her to build an understanding of the learning material which transcends the mere memorizing of information.

### *1.3. Who Are the Trainees?*

The two perspectives, the cognitive-constructionist, and the social constructivist, point to that different learning strategies fit different people, and that one needs to know what their existing experience and knowledge are. In any large organization, also in the industry, there are going to be employees with quite different education, experience, motivation, self-efficacy, and personality, and one should try to find learning strategies for the staff training that fit the characteristics of the employees [15,29]. Although it might be difficult to tailor-fit an educational course to each and everyone's personality traits, one can look for which characteristics are more common among the different groups of employees. For instance, are they more motivated by practical challenges and less with the theoretical ones? Biggs & Tang [30] refer to two archetypes of trainees: Susan has academic aspirations an inner motivation to work with theoretical subjects and a clear idea of what she needs to do to further her career. Robert is less interested in academic pursuits and is not necessarily motivated by curiosity, but rather by the desire to have a good job. He wants to do just about enough to pass the training course. According to Biggs and Tang, traditional academic learning activities are not effective for trainees such as Robert. While Susan can acquire knowledge by attending a lecture, Robert might hear the same words but is not able to connect them to any core elements. Instead, he will try to memorize the parts he needs to pass the test. However, discussion and peer cooperation will help Robert to rise to a higher level [30].

It is plausible to assume that in practical professions there will be more people like Robert than Susan. More active forms of learning are better suited to secure a good education at the workplace for this group of trainees [30,31]. According to the two learning theories presented, this can involve practical learning sessions where the trainees collaborate in holding teaching elements for each other and assess each other work through workshops, discussions, buddy programs, and simulations [31].

### *1.4. What Do They Need to Learn?*

It is important to establish which areas are most important for the organization to develop, and what the workers need to learn [12,14,32,33]. This will help to formulate specific learning outcomes for the trainees. The purpose of such learning goals is to put the trainee's learning first and to make decisions that best tailor the trainee's learning [31]. Also for in-house training in industrial organizations, it will be beneficial to formulate clear goals for exactly which type of skills and knowledge the employees are expected to acquire from the training [31].

The analysis should for example give an account of what information workers need to know by heart, and what information they need to know how and where to access [19]. For an industrial organization, one important learning goal is that the trainee shall be able to use the management system effectively. This is partly a technical skill that can to some extent be memorized. A broader skill is to understand how the management system is constructed. The next level is to understand why the management system is constructed, and the purpose of it. He or she doesn't have to know everything in the management system but must be able to navigate to find the correct procedures for the task at hand and to keep oneself updated on the management system and relevant knowledge concerning work processes and safety. This implies that the training should have a practical emphasis; theoretical training is not sufficient, and practical exercises are required to familiarize with the management system.

### 1.5. Motivation to Learn

Motivation refers to the intensity, direction, and persistence of learning-oriented behaviors in the process of training [15,34]. Motivation to learn is an important factor for effective learning, and is influenced by both individual characteristics and the training itself, but will generally increase if the trainees perceive the training as relevant and useful [32,35,36].

Organizational and supervisory support before and during training can increase motivation to learn, as well as positive experiences during the training itself, for instance, if the workers perceive the training as useful according to their job demands [12,19,32,35]. The employee's expectations for the training can affect their learning, and these expectations can often be improved with proper communication before training in a sound working culture [14,19]. Mandatory training, particularly when safety issues are involved, is also a signal that the management regards this as important [19].

### 1.6. Diversified Training Methods

There are several types of training and in-house educational methods to choose from, and must all be evaluated concerning costs, characteristics of the organization and the trainees, and training outcome. Classroom training and lectures have been downgraded as boring and inefficient, but research shows they can be effective for teaching procedural knowledge [14,37], particularly if one combines lectures with other classroom activities, such as discovery training, problem-based learning, and training in metacognitive skills [19]. Even the old-fashioned and reputedly boring lecture has proven to be quite effective in training several types of skills and tasks, often in conjunction with other training methods [14].

Using diversified training methods is beneficial, and using technology training where it fits. Virtual reality, web-based courses, simulators, e-learning, and video learning, can all be considered, but keep in mind what is the best fit for the trainees, the company, and the aim of the training [15,38]. Technology-based training might require investments in technology and technology support to be effective [12,19,36,39]. For instance, web-based training has some advantages to geographically dispersed companies due to less traveling, but must be set up so it gives the trainee immediate feedback on his or her actions, and so the trainee is given control over the training combined with guidelines on how to utilize this control [12,39,40]. Several studies show that individuals perform better when self-regulation and learner control are supplemented with some form of guidance [14,19,40]. Total self-regulation or total program control are equally ineffective, so there must be a balance between individual control and computer-based instruction [19,39]. Studies indicate that web-based training gets better results than classroom training, but also that the difference was negligible when instructional principles were held constant [12,19,40]. Well-designed instructions are of greater significance than the choice of delivery mode, so plans to implement web-based training should be based on a consideration of whether the content can be learned effectively this way [13,19,39].

Organizations working in high-risk environments, such as in the military and in aviation, have used simulation training with good results [19]. Simulations can range from low-fidelity simulations, such as role-playing, and high-fidelity full-motion simulations. What matters is not the physical fidelity level of the simulator, but the relevance of the content for job performance, the psychological fidelity so to speak [19]. Well-designed simulation training can enhance learning by creating a safe environment for learning by trial and error, context-sensitive instruction, and detailed feedback, particularly for tasks where actual mistakes can cause serious injuries or damage to equipment [19,39,41].

Technological innovation and lower costs have contributed to an increase in the use of simulation training in other areas, such as medicine, maintenance, law enforcement, and emergency management settings [19,39]. Well-designed simulations can give training in realistic settings of reality in a simplified or accelerated model [12,42]. It can be everything from low-tech role-playing to technology-advanced full-motion simulations. It's not about creating an exact model of reality, but a model where the psychological actions are relevant

for the tasks one is training for [19]. This gives the trainee a high degree of control, but this control must be supplemented with instructions or guidelines for the trainee on how to use this control [39].

### 1.7. The Principles of Learning

A recurring problem when new training technologies are introduced is that they are merely used as a different delivery mode of the same training [39]. Technology-based should only be chosen if it's the best way to learn the content—what matters more than the delivery mode is that the instructions are well-designed according to well-known principles of learning [12,13,35].

Active learning is a learning principle advocated by both cognitive constructionism and social constructivism both point to the advantages of active learning [18]. Using new technology in training is also more effective when the trainee is allowed to work actively [12,19,40].

Active learning works since the trainee gets involved with the exploration and interpretation of the learning material, and this creates associations between external impulses and results [16,18,25]. This can for instance be carried out with hands-on training and examples that activate the trainee [43]. It can also involve simulations, interactive web learning, discussion, peer presentations, workshops, and buddy systems.

### 1.8. Repetition and Follow-Up

Skill decay can occur if the employees do not get the opportunity to use the acquired skills and knowledge after the training program is completed [12,14,19]. Cognitive tasks are more susceptible to skill decay than physical tasks. Skill decay can be reduced by repetition, practice, and feedback [12,14,44]. A training program should be followed up by additional learning opportunities, practice and discussion for the employees, and opportunities for them to apply their new skills and abilities in their normal working conditions [12,36,45].

Learning is not a one-time event but a continuous process that takes place in both formal and informal settings. Learning by doing as a learning principle states that people through activity and experience [18,26,32]. A strong supportive climate before and after a training program, both from peers and managers, does influence training outcomes [12,19,34,45]. It means that workers can use each other as learning resources in a continuous learning process, provided that formal training gives the workers the necessary tools and knowledge [12,19,34,46]. This can be particularly useful in developing tacit skills that are normally not acquired through formal training, but through extended periods of experience where the individual develops an intuition for making situational judgments [13,32]. Buddy systems and discussion sessions, both before and after a training program, can make it easier for the employees to use what they have learned, and to develop tacit skills [12,18,36,45]. With ongoing support from the leaders, on-the-job training can lead to greater innovation and tacit skills [13]. Tacit skills are usually not acquired through formal training, but through extended periods of experience where the individual develops an intuition for making sound judgments on how to perform a task [13,47].

## 2. Materials and Methods

27 in-depth interviews with employees in two different companies in the Norwegian oil and gas production sector were conducted. The informants had different tasks and roles in the hierarchy. Some of them were onshore and offshore executives, while others were offshore operators (mechanics, electricians, logistics, and automation). One of the companies manages offshore installations and was chosen since they have recently implemented a new training program for their management system. The other company hires temporary contractors to offshore companies, and their workers must use different types of management systems.

### 2.1. Data Collection Process

In the recruiting process, we used purposeful samples to get units rich in information [48,49]. The informants had to be from companies involved in a high-risk industry, and who were using a management system regularly. It was also a criterion to get a mix of onshore executives, offshore executives such as installation managers and foremen, and offshore workers at the sharp end: automation, electricians, mechanics, and process workers. The management in the two companies helped to recruit the informants, and they were either permanent employees or long-term contractors. They all go through the same training program and are using the management system for all tasks, so the data material covers how people with different educational and professional backgrounds understand the system.

The age of the informants ranged from 25 to 64 years old, with 40–54 as the largest group. 24 were male, and 3 were female. Age and gender were not selection criteria, and both companies are male dominated, but it served the study's purpose to have both experienced and less experienced workers as informants. Three of the informants were in their first year offshore, while the majority had been offshore for 5 to 19 years. The interviews were conducted in a secluded room during normal working hours, either on board at the oil and gas-producing installation or on land.

The semi-structured interview guide had open-ended questions, and every interview started with the informants using their own words to explain the purpose of the management system and their use of it. After that, more detailed questions followed, about which procedures they used, how they learned about the management system, and the shortcomings and advantages of the system.

The duration of the interviews was 40–50 min, with a few exceptions. The interviews with the executives generally lasted longer than the interviews with the operators. The author of this paper conducted and transcribed the interviews. Originally the project was planned for 15 interviews, but after transcription, I decided it would be beneficial to do a second round of interviews in a different company, so nine more interviews were conducted to reach data saturation.

### 2.2. Data Analysis

The six-step approach of thematic analysis was used, as it is described by Braun & Clarke [50]. The constructivist perspective opens for interpretation of the latent meaning of what the informants are saying [50]. For instance, when they talk about how they dislike working with computers and would rather just do the job, this was interpreted as a lack of motivation for using an IT-based management system and that they prefer more practical work and more practical training.

The first round of coding resulted in 23 broad themes. After further review, three main themes were developed: the informants' motivation to learn, the introductory course, and continued learning. The main theme "motivation to learn" includes aspects of how they relate to computers, and how they feel they don't need the management system. The main theme of the "introductory course" includes the sub-themes of unclear learning goals and lack of practical training and repetition. The main theme "continued learning" consists of the sub-themes of formal follow-up, informal conversations, and that they forget skills and information. The author of this paper coded the material, with discussions during the different steps of the coding process with colleagues working on related topics concerning safety.

### 2.3. Ethics

The persons interviewed were informed that the data would be used for scientific publication and gave their consent to this. The sound files were deleted after transcription. The transcriptions were stored securely, without identifying information. The process for using and storing interview data was approved by the Norwegian Centre for Research Data.

### 3. Results

The two companies in this study have similar management systems. They are IT-based and can be accessed from computers at the workstations, where the workers can log on with their personal user, or they can log on to a restricted version with a generic user. The management systems contain procedures, work descriptions, and checklists for all tasks at all levels in the companies, not only hazardous tasks at the sharp end but also administrative tasks, such as writing overtime hours and ordering equipment. This makes the management system quite large, containing a huge amount of information, and the user is supposed to navigate it by clicking on icons in a filing structure that should guide them to the documents they need. All personnel, at the operating and executive level, are expected to use the management system routinely.

The coding process produced three main themes with a total of eight sub-themes. The following section will elaborate on the themes as presented in Table 1.

**Table 1.** Themes and sub-themes.

Main Theme	Sub-Theme
<b>Motivation to learn</b>	Not used to computers Don't need a management system
<b>Introductory course</b>	Unclear learning goals Wants practical training Repeat the training
<b>Continued learning</b>	Formal follow-up Informal conversations Forget what they don't use

#### 3.1. Motivation to Learn

The executives took the worker's motivation to learn about the management system for granted. They expected the workers to do this out of loyalty to the company, but it was clear from the interviews that this motivation couldn't be taken for granted. Several operators stated a general dislike towards using computers, that they did not find the system to be useful and did not understand its purpose.

##### *Not Used to Computers*

The managers expected that the workers had the necessary competence to use the computers. We don't have specific information about the computer skills of the workers, but several of them gave statements suggesting they thought using computers was a hassle, and that they would just do the job instead of sitting in front of a computer.

*11: Why should we sit at the computer and read for an hour when we can just go out and do the job? (Offshore operator—Automation)*

Dislike of computers hurts their motivation to spend time in front of a computer and will also be a disadvantage in the process of learning how to use the management system.

##### *Don't need a management system*

In both companies, the executives said that the management system was there to secure safety in all operations. They talked about how many years of industrial experience was organized in the management system, and that this was very helpful. The workers saw it differently and said they did not need the management system to do their job.

*16: There are some boxes and different columns and such that we can click through, but in the daily work I don't use it at all. I'm not very good at it. (...) I have my own way of doing things. (Offshore worker—Material and logistics)*

Most of the operators could not explain the purpose of the system and saw their own experience as more important for safety and thought that the management system was there to keep the back of the managers safe, not to keep the workers safe. They acknowledged the need for safety measures but did not see the management system as part of this. It seems from this that if the training succeeds in giving the workers a better understanding of the purpose of the management system, it will improve their motivation to use it since the workers who were able to say something about the purpose of the management system also said that it was for their own good.

*26: It's a database, so to speak, with information we can use in our daily work, so it's safe for us and others. (Offshore worker—Material and logistics)*

The informants also stressed the importance of having clear guidelines and procedures to relate to, and that it was also in their own best interest as well as in the company's interest.

*15: When you've worked many years in the North Sea it's kind of in your fingers, so to speak. You know the regulations, you know what you have to deal with. (...) It's not right that we should sit and work with [the management system] because these we have and experience. People who have worked with [petroleum] for a very long time, and they're supposed to sit and fiddle with [the management system]. (Offshore worker—Crane operator)*

Both operators and executives said they had problems navigating the management system, and that it was difficult to find the checklists and procedures they needed for the job. They expressed irritation that they had to skim through a lot of material they thought they did not need to find the exact documents they needed.

*13: There are too many processes and paths in there (...) it's making it difficult to find your way through it. You have to identify the job you're going to do by choosing between several options (...) and then the system is supposed to tell you which procedures you should use. But it is not relevant at all, because as I said, I've tried it, and it doesn't work. (Offshore worker—Mechanic)*

Several informants had found alternative ways of getting the job done. Some informants had simply printed out a bunch of checklists which they kept in a pile in the workshop, so they did not have to use the management system. An obvious drawback is that they would miss out on any updates or changes in the checklists. They acknowledged this, but still found it to be a more practical solution.

### 3.2. Introductory Course

Both companies give their employees a short web-based introductory course to the management system, with a multiple-choice test at the end. The workers can take the same test several times until they reach the required score of 8 out of 10 points. This is a requirement to get a license to work offshore. The course is not repeated. The course is designed to last for two hours, but most workers spend far less time on it. The executives are aware of this and reckoned it takes about half an hour.

#### *Unclear learning goals*

The learning goals were not specified, but the executives said it was important that the workers understood the purpose and the basic structure of the management system.

*3: They should know the background of the management system. Why do we have it? And they need to understand the structure, and that every object is clickable. (Onshore executive—IT Developer)*

Most operators have understood the basic idea of clicking on various icons in the system, but when it came to the purpose of the system, many of them could only describe it vaguely.

*11: If I can describe it, yes? No, I don't know. It is a system that tells you how what you should do and what you shouldn't do. Isn't it? (Offshore worker—Automation)*



It seems that the learning outcome is not quite what was desired.

*Wants practical training*

The workers all said they would like more practical training where they can go through specific tasks on their own.

*10: I think it would be better if they made some group assignments. To present a specific problem we should solve. (...) In my experience, it is better to push the buttons myself, rather than watch someone else do it. (Offshore worker—Electrician)*

The workers said they had to use the management system for a while to get used to it and to figure out how it works.

*Repeat the training.*

Neither company had a formalized system for repetition. One of the informants said that he repeated the course after his first rotation offshore on his initiative and that this helped him a lot.

*18: Generally, you will, or at least I will benefit more from such a course a bit later. I understand that you need some introduction before you start using the [management system], but it is also very helpful to have the course afterward. Because that's when the questions start to pop up when you have started using it. (Offshore worker—Management technician)*

### 3.3. Continued Learning

After the training program, it was learning by doing. There was no repetition or otherwise systematic follow-up of the training program. The workers said they needed some time to get used to the management system this way.

*14: If you have to use it all the time, I guess it will become easy eventually. (Offshore worker—Mechanic)*

The workers said the management system wasn't very user-friendly, but they hoped that this would improve over time.

*Formal follow-up*

Both companies had a formalized system of reviewing the work processes. They are supposed to review two of the most relevant work processes and report on a list when this is carried out. The executives seemed to be more aware of this than the operators. Some of the operators said they would like more formal discussions or meetings about the management system and the procedures, and work through some relevant cases together.

*11: I think there has been some follow-up, in general meetings and such. Morning meetings, or HSE meetings. (Offshore worker—Automation)*

*Informal conversations*

The workers sometimes talk about the management system, and usually with a negative focus, sometimes just to air some frustrations.

*4: You get the feeling you're in a circle and an endless loop. (...) Many people say the same. They get the feeling it's a bit like, well, that you're in a loop. (Offshore executive—Installation manager)*

They also discuss the management system when they face some problems and need help. In general, they rarely mention any positive aspects of the management system but focus on the negative.

*Forget what they don't use*

Some of the informants said that the rotation system, where they are 14 days on the installation and then have 28 days off, is an obstacle when it comes to getting a good routine for using the management system and getting familiar with it.

17: *We're working shifts. We have four weeks off, and then we're on the platform for fourteen days. When you're at home, you don't think about work. So, the stuff you did six months ago, you kind of forget. It's just how humans are, I think. (Offshore worker—Laboratory technician)*

#### 4. Discussion

The management system with its procedures and work description is designed to prevent accidents that can cause human injury and environmental damage in high-risk industries, but it only works if the employees know how to use it and why they should use it.

Executives and workers talked about the management system in very different terms. The executives talked about it as an organized collection of industrial experience gathered over many years to advise on best practices. The workers were vaguer when they talked about the management system and were more inclined to think they did not need it.

Workers in both companies in this study undergo a short web-based theory course on the management system. There are no practical exercises or repetitions, but a multiple-choice test at the end. The workers said that had to use the management system for a while to familiarize themselves with it and to figure out how it worked. This process goes on at the same time as they are responsible for performing safety-regulated tasks, instead of an isolated and controlled learning situation.

Previous research in the same field points to that a lack of adequate formal training can be interpreted by the workers as a signal that active use of the management system is not important [11]. Also in the present study, the short theoretical training course without any repetition or practical exercises sends a signal to the workers that the system isn't that important. A quick way to improve this would be to repeat the existing course, but for any major improvement to happen the training program needs to be revised and invested in. This costs time and money but is also an investment in the workers' skills and safety.

According to cognitive constructionism and social constructivism, the training can be significantly improved by having formulated learning goals, and identifying who the trainees are and what motivates them to learn [17,18]. New learning builds on the trainees' existing knowledge, so one must know what the existing building blocks are [24].

These perspectives have several traits in common with Training Needs Analysis (TNA), which also stresses the importance of making sure the organization knows what kind of competence it needs, and how to design the knowledge structures in the organizations, including training, to fit the characteristics of the workers [12,13,19,51]. The management system contains a large number of procedures and work descriptions. The perspectives presented in this study imply that the training does not have to teach the workers to know everything by heart, but rather enable them to find the procedures they need when they need them and give them an understanding of when to adapt the procedures to the immediate situation, rather than trusting them blindly [8,19].

The characteristics of the workers should be given high priority when designing the training program. If the workers resemble Robert more than Susan of the two archetypes of trainees introduced by Biggs and Tang [30], active learning forms will improve learning outcomes. The workers in this study said they are more used to and prefer, practical tasks to theory. This can be taken into account when designing training, and one could consider training strategies such as workshops with peers, practical assignments, simulations, and buddy systems. Social constructivism sees the individual as an active participant in the learning process and will learn better in social settings with their peers [24].

If the workers see the training as useful for themselves, it improves their motivation to learn [32,35,36]. Motivation can be increased by organizational and supervisory support before and during training. The content of the training itself can also affect motivation, especially if it helps the workers understand the purpose of the management system and why it is useful for them.

Although the workers prefer practical training, they will need a theoretical introduction to the management system. This can be carried out with classroom training or web-based courses. The content of the training is more important than the delivery mode, so companies should choose the most practical one. For instance, classroom training and lectures can open more dialogue-based learning in a supportive environment but can be inconvenient and costly to set up for geographically dispersed organizations. After the introduction, practical exercises are required to learn how to use the management system. Practical training could be carried out with classroom training, simulations, workshops, or on-the-job training. On-the-job training can help to improve innovation and tacit skills and to establish communities of practice where the workers can use each other as learning resources [13,19]. Simulation training could be set up, either as a web-based course or as workshop sessions on the worksite.

Repetition will help the workers to get a combination of practical knowledge and theoretical understanding of the management system and the procedures and will also reduce skill decay. Repetition can be carried out through on-the-job training, workshop sessions, and simulations. Buddy programs and on-the-job training will also be helpful and can be supplemented with workshop sessions and discussions. This can also help to ensure support from supervisors and peers, both before and after a training program [12,19,36].

## 5. Conclusions

While executives perceive the management system as important for safety, the attitude among the operators is often that they can do their job without it. The workers acknowledge the need for safety measures, but they don't see how the management system is supposed to ensure safety, and hence, tend to regard it as less important. This negatively influences their motivation to learn.

The training should focus on establishing an understanding of why and how the management system has been constructed in the first place, what its purpose is, and how previous experience over many years has been accumulated here. Training should help the workers to understand the limitations of the system, and to develop the skills needed to be able to evaluate when and how they should adapt the procedures to a given situation.

Training must be designed to fit the trainees and their preferred way of learning, and what motivates them. Motivation can be driven by material things such as having a good job, being safe at work, possibilities for promotion, and so on, but in a training program one must also facilitate the inner motivation driven by the joy of learning and personal development. Further research should aim to identify how training programs can be designed to fit the inner motivation of operators in industrial settings.

The gas and petroleum producing sector is a high-risk industry where the consequences for accidents can be catastrophic for animal life and the environment. The future of fossil energy is debated, and many are looking for developing a more sustainable energy industry. Technology development will be a part of this, and technological rich workplaces requires investments in human resources, such as proper staff training to create a good working and learning culture that will help to prevent accidents in the energy industry.

## 6. Limitations

Though the data material is rich, it is also context-bound to gas and petroleum production on the Norwegian shelf. Both companies in this study are Norwegian, and all of the informants are Norwegian. It addressed social and cultural traits, and these can be very different in other countries, and in companies with employees from many countries. There is no guarantee that the findings are relevant for other contexts, but hopefully, the data description is rich enough to evaluate their usefulness for training programs in similar contexts.

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