



Learning from incidents: applying the 3-P model of workplace learning

Journal:	<i>Journal of Workplace Learning</i>
Manuscript ID	JWL-04-2021-0050.R2
Manuscript Type:	Research Paper
Keywords:	learning organization, Organizational learning, Workplace learning, Informal learning, Knowledge processes

SCHOLARONE™
Manuscripts

Learning from incidents: applying the 3-P model of workplace learning

Abstract

Purpose

Learning from incidents (LFI) is an organisational process that high-risk industries use following an accident or near-miss to prevent similar events. Literature on the topic has presented a fragmented conceptualisation of learning in this context. This article presents a holistic taxonomy of the different aspects of LFI from the perspective of front-line staff.

Design/Methodology/Approach

The 3-P model of workplace learning was used to guide a thematic analysis of interview data from 45 participants, exploring learner factors, learning context, learning processes, and learning products.

Findings

The analysis was used to create a taxonomy of 21 aspects of learning, grouped into themes using the 3-P model of workplace learning. Many of the aspects of learning reflected previous literature, such as the importance of open communication. The analysis additionally demonstrated the interconnected nature of organisational and individual level learning, as well as how formal resources are needed to support informal learning in this context.

Originality

This study presents a holistic taxonomy of LFI from the perspective of front-line staff, addressing a known challenge of LFI literature being fragmented. Additionally, it provides examples of how aspects of organisational learning would influence individual-level learning and vice versa, adding to the relatively sparse number of studies that have explored this aspect. Finally, the paper highlights how informal learning in contexts where workers continually need to make sense of unseen hazards depends on formal learning activities and resources.

Keywords:

Learning from incidents; 3-P model; workplace learning; thematic analysis; organisational learning; safety science

Introduction

Following an accident or a near-miss, organisations in high-risk industries will learn by investigating the events that led to the incident (Drupsteen *et al.*, 2013). Following the investigation, a summary of the incident and its causes will be sent to workers across the organisation, allowing individuals to reflect on their own practice without the need to experience an unfortunate event themselves (Author B, 2010). [This process, known as learning from incidents \(LFI\), facilitates organisations learning from the past to develop safer working practices](#) (Le Coze, 2013).

LFI literature has often used a reduction in the number of incidents as a proxy for learning (Madsen *et al.*, 2016). In this line of thinking, learning leads to safer behaviour and therefore fewer incidents. Ergo, if fewer incidents occur then learning must have happened. However, Author B (2017b) has called for a deeper understanding of how learning is fostered after an incident. Studies have shown that learning in this context is complex and takes several forms, ranging from investigators interpreting evidence, to teams discussing an incident summary (Stemn *et al.*, 2018; Author B, 2010). [Different aspects of this multi-faceted process have been researched, but the literature remains relatively fragmented without a clear holistic understanding of what it takes to learn and what it should result in](#) (Author B, 2017b). Furthermore, [research has yet to fully explore what front-line staff understand as the objectives of LFI. As it is front-line staff who work directly with hazards, how they interpret learning activities is an important perspective to understand](#) (Engeström and Kerosuo, 2007). This article addresses the identified gap by presenting a thematic analysis of 45 interviews with workers from three organisations in the energy sector. The analysis identified what workers believed to be successful LFI. In-line with the 3-P model (Tynjälä, 2013), learning was considered from the perspective of desired outcomes, effective learning activities, and supportive environmental and individual factors.

Theoretical Framework

Learning from Incidents

An incident is defined as an unexpected event that led to a negative outcome or could potentially have done so (Hollnagel, 2014). LFI is an organisational process which consists of seven stages: reporting an incident, investigating, summarising investigation findings, distributing that summary, teams reflecting on how the incident is relevant to their own context, making changes, and, finally, evaluating those changes (Drupsteen *et al.*, 2013; Author B, 2017a). This process should result in learning at both the organisational and individual level. Learning at the organisational level refers to changes to the structures, procedures, and environment in which workers are situated (Author B, 2010). [Knowledge from decades of experiences is embedded into sociocultural tools, which workers make use of during their tasks](#) (Lukic, 2012). [Organisational learning in LFI, therefore, aims to update sociocultural tools and affect the practice of a multitude of workers.](#)

Individual learning in LFI is achieved through guided reflection using incident summaries. Following an investigation, findings will be summarised into a short report or slideshow. This summary will be shared with workers across the organisation, with the aim to prompt reflection. Often front-line teams will discuss the 'lessons learnt' from the incident and make sense of them in a way that is meaningful for their own work (Carroll, 1995). Additionally, individuals learn outside of formal incident meetings by reactively discussing unexpected events with colleagues (Vastveit *et al.*, 2015). While the formal LFI process creates opportunities for individuals to reflect on the relevance of an incident to their own work, workers are continually making sense of incident-information as they encounter new situations in their daily practices. In other words, while change to organisational

1
2
3 tools is mainly driven by the formal LFI process, individual-level learning occurs through both formal
4 and informal means.
5

6 *3-P model of Workplace Learning in LFI*

7
8 The 3-P model of workplace learning is a framework that describes interconnected elements of
9 learning in a professional environment (Tynjälä, 2013). It has been operationalised to describe both
10 the individual and organisational aspects of workplace learning processes (e.g., Böhn and Deutscher,
11 2021). In the model, learning consists of three Ps: presage, process, and product. Presage describes
12 elements that would influence how learning occurs and is divided into two sub-categories: learner
13 factors and learning context. Process encapsulates the variety of different learning activities that
14 occur in the workplace, including both formal and informal aspects. Finally, product refers to
15 learning outcomes. While there are multiple conceptual models of workplace learning, the 3-P
16 model is simple enough for practitioners to understand (Biggs, 1993) but complex enough to address
17 the challenge of unifying disparate LFI literature (Le Coze, 2013).
18
19

20
21 LFI literature has examined elements of learning from across the 3-P model. When
22 considering presage, for instance, Author B's (2013) qualitative investigation of agency in LFI found
23 several learner factors that would affect how a worker engaged with LFI, such as safety values. With
24 regards to learning environment, Tamuz *et al.*'s (2011) case study of an incident in healthcare
25 showed how context can affect incident learning processes. The case study followed a group of
26 pharmacists who used the investigation of an incident as leverage to push through already desired
27 organisational changes. In this case, the learning process was used not for reflection, but to gain
28 buy-in from management for beneficial changes identified by prior reflection on smaller incidents.
29 While previous work has identified a range of LFI learner factors and environmental influences,
30 studies have not yet identified overarching themes across these two highly interconnected
31 categories that affect the learning process. This analysis will therefore begin to address this gap by
32 exploring, from the perspective of the front-line, what learner factors and contextual elements
33 impact their engagement with LFI.
34
35

36
37 In addition to presage, LFI literature has provided insight into learning processes and products.
38 There are several different activities that are part of the learning process in LFI, such as discussing an
39 incident with colleagues or exploring recent incident trends (Jacobsson *et al.*, 2012; Rossignol and
40 Hommels, 2017). Although the exact format of the activity may vary, research has found that there
41 are several qualities that would be important across activities in LFI. Examples include organisations
42 providing sufficient time for reflection (Drupsteen and Hasle, 2014), a culture of open
43 communication (Edmondson 2004), and summaries that do not oversimplify incidents (Braut and
44 Njå, 2013).
45
46

47
48 As stated in the introduction of this paper, the aim of this study is to identify what workers
49 perceive as successful learning. As such, rather than naming different activities involved in LFI, the
50 analysis will identify the qualities that are necessary for activities to effectively support learning. In
51 an exploration of LFI practices at a refinery, Vastveit *et al.* (2015) observed that learning occurred
52 through structured activities and daily work tasks, supporting other studies that have found that
53 workers learn about safety through praxis (Yap and Choy, 2018). The analysis will therefore consider
54 both formal and informal learning processes. Finally, studies have identified several examples of
55 desirable LFI learning products. Individual-oriented outcomes of LFI include changes in practice,
56 improved collaboration, and better understanding of risks (Anderson *et al.*, 2013). At the
57 organisational level, learning outcomes might be changes to procedures, such as adding additional
58 checks before carrying out a task, or a database of high-quality incident reports (Jacobsson *et al.*,
59
60

2012). As described by Author B (2017b), studies to date have often focused on either organisational learning products or individual learning products. This analysis complements previous work, such as Lukic (2012), which explored both levels of learning. As with the presage and process themes, the analysis will explore desirable organisational and individual learning products from the perspective of the learners in this context.

Research Methods

Settings and Participants

Forty-five interviews were conducted with employees of three multi-national energy organisations. All organisations were recruited by advertising the study at an LFI event at the Energy Institute in the UK, and met the following criteria:

- Part of a global energy organisation
- Well-established LFI system
- Committed senior manager who would act as the gatekeeper

Table I shows the characteristics of the three organisations. Participants were recruited from departments in European units of each organisation. In Company A and Company C, participants worked at a single location, close to their colleagues. Company B workers were divided into teams that conducted work at clients' homes. As their job required them to drive to different locations, workers in Company B did not spend much time physically together as a team.

→ Insert Table I about here

Eighteen participants took part in interviews from Company A from both the production and engineering departments. Eleven participants came from four teams of engineers in Company B. Sixteen workers from a production department of Company C participated in interviews. As can be seen in Table II, participants were from both front-line workers and managerial positions. Managerial positions in this study refer to those who led a front-line team or were directly connected to supporting front-line workers. All participants were male.

→ Insert Table II about here

Participants were selected in-line with maximum variation sampling, targeting those from diverse backgrounds to maximise the potential for differing views to emerge (Suri, 2011). In this study, a participant's background was based on their job role (engineering, production, front-line, management) and their position in social networks (see Author A *et al.*, 2018).

The study was approved by the Open University's ethics committee (HREC/XXX-blinded). All participants were informed of the purpose of the study and consented to participation before the interviews were conducted.

Data Collection and Analysis

When asked directly about learning, professionals usually describe formal training and neglect informal processes, such as learning on the job (Simons and Ruijters, 2004). Interview questions therefore focused on examples of times when learning would have occurred. For instance, gatekeepers provided an example of a large incident that had occurred either at the organisation or in the industry. One of the requirements for this incident was that the organisation had devoted time and resources to learning from it. The incident was described to participants who were then asked what changes it had prompted in the organisation, and whether it had impacted their own work.

Thematic analysis was chosen for this study due to its ability to explore perceptions of complex phenomena, such as learning. As highlighted by Braun and Clarke (2020), there are multiple types of thematic analysis, which each has its own underpinning assumptions. The authors employed the framework method of thematic analysis outlined by Gale et al. (2013). The first author initially used the transcripts of participants from Company A to iteratively create a codebook containing themes, codes, and descriptions. Each code represented an aspect of learning in the context of LFI. The inductively generated codes were deductively grouped into themes based on the 3-P model of workplace learning (Tynjälä, 2013). Analysis was supported using the NVivo version 11 software package.

Two additional researchers independently applied the coding scheme to four interview transcripts and the differences with the first author's application were discussed. Several steps were taken to further reflect on the findings: presentations to representatives from the energy sector during the analysis, presentations to participants as findings emerged, and converting the findings into a workshop to actively engage participants in thinking about the concepts and results. An assumption of the analysis conducted in this study is that knowledge is situated, and the researchers' understandings are a resource rather than a bias (Braun and Clarke, 2020). As such, concepts such as data saturation and inter-rater reliability were not appropriate in this analytical approach.

Findings

Twenty-one codes were identified and organised into the taxonomy of learning shown in Table III. Codes were grouped into themes based on the 3-P model of workplace learning: learner factors and context (presage), learning process, and learning product. While the taxonomy shows each code under one of these four themes, some codes could be considered to overlap multiple themes. In general, presage codes were used for individual qualities (e.g., locative knowledge) or organisational structures and qualities (e.g., organisational memory) that existed outside of LFI oriented activities. Process codes related to the qualities of learning activities. Products described desired changes. Rather than strict categorisation, the codes have been grouped in this manner to help readers make sense of the findings and discussion. To further aid with this sensemaking, the descriptors 'individual', 'organisational', 'formal' and 'informal' are listed next to each code in Table III.

➔ Insert Table III about here

1
2
3 The proportion of participants in each organisation who mentioned each code is displayed in Figure
4 1. In thematic analysis, a code is not necessarily more important because it was mentioned more
5 frequently (Guest *et al.*, 2014). Nonetheless, frequency can be useful during the interpretation of
6 findings and provides transparency.
7
8
9

10 → Insert Figure 1 here

11
12 **Fig 1** Heat-map of aspects of learning mentioned by participants in each organisation
13
14

15 16 *Learner Factors*

17 Several of the learner factor codes related to how participants understood the purpose of receiving
18 incident summaries. When asked how workers should change after receiving a summary, a common
19 response was that changes were usually not necessary. As can be seen from the below quotation,
20 summaries were viewed as a way to develop a safety-oriented mindset, rather than as a driver of
21 change:
22
23
24

25
26
27 *'It's more just opened your eyes, just make sure you're being safe. I mean touch wood I've
28 never had any accidents or anything, but yeah it does open your eyes to just take your time'*

29
30 *Participant B4, front-line*
31
32

33 The below quotation from Participant C14 illustrates why a mind-set rather than updated practice
34 might be perceived as the aim of incident summaries: to combat risk normalisation. Working in
35 environments with dangerous hazards where incidents rarely happen, it would be easy to become
36 accustomed to the level of risk.
37
38
39

40
41 *'I think if a massive incident happened somewhere in the world today, and then we all got to
42 find out about it, it would make everybody stand back for about 5 minutes and think about
43 what they were doing... But over a period of time it gets forgotten about the, it gets relaxed
44 doesn't it? Everything goes back to normal.'*
45

46
47 *Participant C14, front-line*
48
49

50 As can be seen from Figure 1, developing a safety-mindset was spoken about far more by
51 participants than motivation to learn. This is in sharp contrast with the LFI literature, where
52 motivation has been acknowledged as important to both learning and safety culture (Author B,
53 2014). The few participants who did mention motivation to learn tended to be managers, such as
54 Participant A8. In his view, if front-line workers were not motivated to learn and change, then any
55 updates to procedures would not be implemented. Since many participants felt that there was no
56 need to change behaviours, it is perhaps not surprising that few people discussed motivation to
57 learn. Participants appeared to be highly motivated to act safely, but this is subtly different to being
58 motivated to learn. Safety usually involves acting in a standardised way that minimises risk, whereas
59
60

1
2
3 learning involves change (Author B, 2014). Organisations must therefore carefully consider how they
4 intend incident summaries to support learning and make this expectation clear to their workforce.
5

6 In relation to informal learning, locative knowledge was acknowledged as important. For
7 example, Participant B9 was a front-line worker who was the designated coach for his team. Due to
8 his role, other team members would frequently contact him with safety concerns. Despite knowing
9 the answers, Participant B9 would not usually tell an engineer what they wanted to know, rather
10 direct them to the location where they could find that information. He commented, "it's all well and
11 good me going 'that's the answer', but they need to find out why it is a risk." While the formal LFI
12 process creates opportunities to discuss and reflect on incident summaries, incident-related
13 knowledge needs to be embedded into other places, such as databases, that can support informal
14 and reactive learning. However, this information is only of use if workers know where to find it.
15
16

17 *Learning Context*

18 Most learning context codes related to the formal organisational setting. For example,
19 communication pathways were described as important because top-down dissemination was the
20 main route through which incident summaries were received. Formal communication pathways
21 connected strongly to another context code: safety as an organisational value. For example,
22 Participant B5 explained the difference he had felt in Company B's values since the new head of their
23 department made it clear that safety should be prioritised over production. The shift in focus made
24 Participant B5 feel that he could now contact his new department head directly with ideas and
25 concerns. The shift in culture had created new avenues of formal communication, providing him
26 with agency to engage with safety and learning. Without a sense that safety was valued by the
27 organisation, front-line staff could see incident discussions as token exercises rather than
28 opportunities for learning. Transparency was another code that related to safety as an
29 organisational value. Participant A6 described an experience where he had requested maintenance
30 on some equipment, but the request was declined without an explanation. Participant A6 found the
31 experience frustrating, interpreting the response as demonstrating an unwillingness to prioritise
32 safety. As highlighted by Author B (2013), these types of perceptions and feelings can often impact
33 willingness to engage in learning activities.
34
35
36
37
38

39 During interviews participants mentioned using several formal resources that contained
40 insights embedded into organisational memory. For example, incidents would often be used as
41 examples in training courses to explain why tasks were conducted in a certain manner. Databases of
42 past incidents were also a key form of organisational memory. Multiple participants provided
43 examples of accessing these formal databases in their informal learning and impromptu
44 communication. For example, Participant C12 said:
45
46
47
48

49 *'I went online and read the, the inquiry reports into what exactly happened and I said, and I*
50 *printed it off and I underlined or highlighted various things where it was, I said, look it's*
51 *exactly the same. We're doing exactly the same as what they were doing.'*
52

53 *C12, front-line*
54
55
56

57 In this example, Participant C12 used the database as a resource during discussions with co-workers
58 on safety to make sense of the risks involved with certain courses of action. This example also
59 demonstrates the perceived value of 'impromptu communication', as participants spoke about
60

1
2
3 continually talking to colleagues, asking for opinions while they informally learned and made sense
4 of their work.
5

6 The final learning context code was company strategy reacts to incidents, which was also
7 connected closely to demonstrating safety as an organisational priority. One example of this code
8 was allocation of resources to safety; in Company B, Participant B9 described how time was set aside
9 at each team meeting to check on the safety of vehicles. Being provided with time for safety tasks
10 emphasised that it was something that should be prioritised. However, company strategy also
11 included organisational policies such as hiring, annual reviews, and disciplinary action. Participant C7
12 provided this example of the organisation's internal policies matching the espoused importance of
13 safety:
14
15

16
17
18 *'Our bonus that we get paid in March, we get paid it according to us meeting certain criteria*
19 *within the refinery, as a refinery and also the company as a whole, how they perform. It*
20 *doesn't just go on performance of production it goes on safety, and it goes on everything*
21 *else.'*
22

23 *C7, front-line*
24

25 However, Participant C7 later noted that this was a double-edged sword, as linking a bonus to safety
26 performance could lead to incidents not being reported. Aligning policies so that safety is valued is
27 not an easy task, but would have a large effect on engagement with incident-related learning
28 activities.
29
30

31 32 *Learning Process*

33 Participants spoke about several factors that impacted how effectively they learnt as individuals. In
34 both formal and informal settings, open and honest communication was viewed as necessary to
35 enable people to share their own experiences and mistakes, as well as respectfully challenge each
36 other. In formal settings, the quality of incident summary affected how effectively learning occurred.
37 In the quotation below, Participant C1 described the importance of the summary format as part of
38 its overall quality, drawing on experiences of summaries which had contained so many details that it
39 was difficult to make sense of the contents.
40
41
42
43

44
45 *'Which, like I say, can be multiple pages of information which people aren't going to read and*
46 *they'll miss the point that they're trying to get to. So that's the biggest thing, is just purely*
47 *readability.'*
48

49 *Participant C1, management*
50
51
52

53 Participant A6 added that the nature of the incident was important to consider, as high-quality
54 incident summaries should be tailored to the context in which they were being received. If the
55 summary was perceived as irrelevant, then nobody would learn.
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

'Sometimes there are eye-openers, that things that happen on the other side of the world could also happen here, because you have the same situation. So that's always good. And sometimes you get examples, and you think "well, that could never happen here".'

Participant A6, management

However, perceived relevance and overall engagement depended not just on the quality of the incident summary, but on an 'impactful delivery'. In particular, the facilitation skills of team leaders, who were tasked with delivering incident learning sessions, played a large role in the effectiveness of individual formal LFI. Participants described different facilitation approaches with varying levels of interactivity. Interactive approaches that involved thought provoking questions or sharing experiences were perceived as the most effective activities.

While incident summaries were the focus of individual learning activities, an organisational-level learning process was also described by participants: evaluating whether changes made had successfully reduced risk. As described above, LFI at the organisational level means updating sociocultural tools that will influence multiple workers' practices. Participant A17 described below how organisations inconsistently carried out evaluation to understand if any changes made to sociocultural tools would achieve their goals. The evaluation process is particularly important as incidents are rare events. It would be possible to make several changes that do nothing to improve the organisation's tools, or even have an unforeseen detrimental effect. Without evaluation the organisation would not understand that it had made ineffectual changes until another incident occurred.

'My experience is, of learning from some incidents, is that you always look that, you always look back and you make changes, but you don't check if your consequences, if the consequences of your changes are something you want.'

Participant A17, front-line

Making changes without evaluating their effectiveness could also have an impact on the motivation of workers to learn. Zhao and Olivera (2006) **proposed that** learning increases the motivation to report incidents, the first step in the LFI process. While evaluating the impact of an incident follow-up appeared to be inconsistent, all organisations emphasised monitoring activities, such as analysing incident trends and conducting audits. Time for monitoring general work practices was built into the routines of the organisation. As other studies have found that time is often a limiting factor on the quality of LFI (Stemn *et al.*, 2020), it may be beneficial for organisations to build evaluation tasks of incident-related changes into regular monitoring activities.

Learning Products

Learning products mentioned during the interviews focused on changes at both the organisational and individual levels. In terms of sociocultural tools, participants mentioned updating procedures, best practice, technology, and safety barriers. For example, workers spoke about additional checklists that had been added to procedures following an incident. The difference between procedures and best practice was necessary due to a distinction made by participants between the ways that a task was performed in practice and the official procedures. For example, following an

1
2
3 incident at one organisation, participants described how the investigation team had concluded that
4 their procedure was effective if followed. Rather than update the procedure, the investigation team
5 recommended re-training workers on the correct procedure and increased the number of audits
6 related to this task, hopefully changing perceived best practice. Updates to best practice also
7 occurred because of informal learning, resulting from discussions between colleagues. However,
8 these changes were kept as local improvements to a specific team's work. An area for future
9 exploration in LFI would be investigating how improvements to different teams' best practices could
10 be shared across an organisation. Without avenues to share best practice, each team could come to
11 drastically different conclusions about how an incident is relevant to their work and update their
12 practice accordingly. At best, good ideas from one team will not be capitalised on by another. At
13 worst, the increasingly diverse practices of teams will cause incorrect assumptions about the work of
14 others and could lead to an incident.

15
16
17
18 At the individual-level, interviews contained examples of learning by improved knowledge of
19 hazards and procedures. For example, in Company C, one participant (Participant C10, front-line)
20 described an incident summary that he had received from another organisation, where a drum had
21 been filled with hot oil and opened prematurely. Under normal circumstances, the oil was cooled
22 using steam followed by water, and then left for three weeks before it was safe to open. In this
23 incident, only steam had been used and then the oil was left an additional five days to cool, resulting
24 in an accident once opened as the oil was still extremely hot. The participant commented that he
25 had not been aware of how long it took oil to lose its heat and would have most likely made the
26 same mistake. His knowledge of the risks of hot oil had increased due to this incident. Participant B2
27 (front-line), described a similar situation after receiving information on how a colleague had handled
28 an incident related to carbon monoxide. The incident was shared in a team meeting as an example
29 of how his colleague had correctly dealt with the hazard. Participant B2 realised that his knowledge
30 of this procedure had been incomplete, and unknowingly, he had not followed it in the past. In this
31 case, discussing the event allowed a participant to reflect on his past performance and understand
32 how the steps in the procedure managed risk.

33 Discussion

34
35
36
37 This article presented the results of a thematic analysis to conceptualise what 45 workers in three
38 energy companies perceived as successful LFI. The codes were grouped into themes based on the 3-
39 P model of learning. The presented taxonomy builds on work, such as Lukic (2012), that explores the
40 organisational, individual, formal, and informal aspects of a complex organisational learning system.
41 Structuring the taxonomy around the 3-P model of workplace learning highlighted the
42 interconnected nature of individual and organisational learning processes in this context. For
43 example, the act of evaluating whether changes following an incident achieved their goals
44 demonstrates the importance of safety. From the perspective of individuals, knowing that the
45 organisation values safety and dedicates time to evaluating changes will have consequences for their
46 motivation to learn from incident summaries (Author B, 2013; Zhao and Olivera, 2006).
47 Organisations are dynamic entities, meaning that it is difficult to investigate every aspect of a multi-
48 level learning process such as LFI. However, with heuristics such as the 3-P model, it is possible for
49 researchers to be explicit about what part of the learning process they are investigating and consider
50 how that may connect to other pieces of the puzzle.

51
52
53 In a similar manner, the examples presented by participants in this study showed a strong
54 link between formal and informal learning. Following incidents, companies invest time into creating
55 resources that integrate into organisational memory, such as incident databases or learning
56
57
58
59
60

1
2
3 materials for safety discussions. Informal learning in high-risk environments where many hazards
4 cannot be seen requires a high degree of sensemaking. Formal meetings create opportunities for
5 directed discussion which can then be useful while contextualising information on the job. Equally,
6 formal informational resources, such as databases, are essential when workers encounter
7 unexpected situations and try to assess if an incident is likely to occur. Further exploring how formal
8 learning activities and resources support informal learning in the context of LFI would be a beneficial
9 avenue of research.
10
11

12 *Limitations and Future Directions for Research*

14 This study's methods have several limitations that should be addressed in future research. Thematic
15 analysis allows researchers to summarise the key themes of participants' views. However, each
16 learner factor, learning context, and learning process code is likely to differ in influence on the
17 learning products. The magnitude of this influence cannot be assessed through qualitative methods.
18 Future work should quantitatively investigate the impact of improving the different influencers on
19 achieving desired learning products. From a practical perspective, organisations will want to improve
20 the aspects of their learning systems that will result in the biggest gains. Quantitative assessment of
21 the different aspects of learning will therefore increase the practical value of the taxonomy.
22
23

24 Furthermore, the results presented here are based on the perceptions of participants. The
25 taxonomy of learning matches previous literature well, lending validity to the findings. However, it is
26 likely that some important aspects of LFI were not mentioned by participants and are therefore
27 missing from the taxonomy. There are a variety of methods that could surface some of these factors,
28 such as learning analytics or observational studies.
29
30

31 **Conclusion**

32 This article uses Tynjälä's (2013) 3-P model of workplace learning to present a taxonomy of the
33 different components of successful learning in LFI from the perspective of workers. The taxonomy is
34 a starting point for understanding how practitioners perceive learning. As LFI literature has
35 presented a fragmented understanding of learning (Le Coze, 2013), studies should be explicit about
36 what aspect of learning is being investigated. [The findings of this study highlight the interconnect
37 nature of individual, organisational, formal, and informal learning in this context.](#)
38
39
40
41

42 **References**

- 43 Anderson, J. E., Kodate, N., Walters, R. and Dodds, A. (2013), "Can incident reporting improve
44 safety? Healthcare practitioners' views of the effectiveness of incident reporting",
45 *International Journal for Quality in Health Care*, Vol. 25 No. 2, pp.141–150,
46 DOI:10.1093/intqhc/mzs081.
47
48 Author A, Author B and Author C. (2018) [details omitted for peer review]
49
50 Author B. (2013) [details omitted for peer review]
51
52 Author B (2014) [details omitted for peer review]
53
54 Author B. (2017a) [details omitted for peer review]
55
56 Author B. (2017b) [details omitted for peer review]
57
58
59
60

- 1
2
3 Biggs, J. B. (1993), "From theory to practice: a cognitive systems approach", *Higher Education*
4 *Research and Development*, Vol. 12 No. 1, pp. 73–85.
5
6 Böhn, S. and Deutscher, V. K. (2021), "Development and validation of a learning quality inventory for
7 in-company training in VET (VET-LQI)", *Vocations and Learning*, Vol. 14, pp.23-53,
8 DOI:10.1007/s12186-020-09251-3.
9
10 Braun, V. and Clarke, V. (2020), "One size fits all? What counts as quality practice in (reflexive)
11 thematic analysis?", *Qualitative Research in Psychology*,
12 DOI:10.1080/14780887.2020.1769238.
13
14 Braut, G. S. and Njå, O. (2013), "Components of a tool to address learning from accident
15 investigation", *International Journal of Disaster Risk Reduction*, Vol. 6, pp.40–49,
16 DOI:10.1016/j.ijdr.2013.03.006.
17
18 Carroll, J. S. (1995), "Incident reviews in high-hazard industries: sense making and learning under
19 ambiguity and accountability", *Industrial & Environmental Crisis Quarterly*, Vol. 9 No. 2,
20 pp.175–197, DOI:10.1136/QHC.11.1.51.
21
22 Drupsteen, L., Groeneweg, J. and Zwetsloot, G. I. J. M. (2013), "Critical steps in learning from
23 incidents: using learning potential in the process from reporting an incident to accident
24 prevention", *International Journal of Occupational Safety and Ergonomics*, Vol. 19 No. 1,
25 pp.63–77, DOI:10.1080/10803548.2013.11076966.
26
27 Drupsteen, L. and Hasle, P. (2014), "Why do organizations not learn from incidents? Bottlenecks,
28 causes and conditions for a failure to effectively learn.", *Accident Analysis & Prevention*, Vol.
29 72, pp.351–358, DOI:10.1016/j.aap.2014.07.027.
30
31 Edmondson, A. C. (2004), "Learning from failure in health care: frequent opportunities, pervasive
32 barriers", *BMJ Quality & Safety*, Vol. 13 No. suppl 2, pp.ii3–ii9.
33
34 Engeström, Y. and Kerosuo, H. (2007), "From workplace learning to inter-organizational learning and
35 back: the contribution of activity theory." *Journal of Workplace Learning*, Vol. 19 No. 6,
36 pp.336–342, DOI:10.1108/13665620710777084.
37
38 Gale, N. K., Heath, G., Cameron, E., Rashid, S. and Redwood, S. (2013), "Using the framework method
39 for the analysis of qualitative data in multi-disciplinary health research", *BMC Medical*
40 *Research Methodology*, Vol. 13 No. 117, DOI:10.1186/1471-2288-13-117.
41
42 Guest, G., MacQueen, K. and Namey, E. (2014), *Applied thematic analysis*, Sage, Thousand Oaks, CA.
43
44 Hollnagel, E. (2014), "Is safety a subject for science?" *Safety Science*, Vol. 67, pp.21-24,
45 DOI:10.1016/j.ssci.2013.07.025.
46
47 Jacobsson, A., Ek, Å. and Akselsson, R. (2012), "Learning from incidents – a method for assessing the
48 effectiveness of the learning cycle", *Journal of Loss Prevention in the Process Industries*, Vol.
49 25 No.3, pp.561–570, DOI:10.1016/j.jlp.2011.12.013.
50
51 Le Coze, J. C. (2013), "What have we learned about learning from accidents? Post-disasters
52 reflections", *Safety Science*, Vol. 51 No. 1, pp.441–453, DOI:10.1016/j.ssci.2012.07.007
53
54
55
56
57
58
59
60

- 1
2
3 Madsen, P., Dillon, R. L. and Tinsley, C. H. (2016), "Airline safety improvement through experience
4 with near-misses: a cautionary tale", *Risk Analysis*, Vol. 36 No. 5, pp.1054–1066,
5 DOI:10.1111/risa.12503
6
- 7
8 Rossignol, N. and Hommels, A. (2017), "Meanings and practices of learning from incidents: a social
9 constructivist perspective of incident reporting systems", *Technology Analysis & Strategic
10 Management*, Vol. 29 No. 4, pp. 370–380, DOI:10.1080/09537325.2016.1213805.
11
- 12 Simons, P. R.-J. and Ruijters, M. C. P. (2004), "Learning professionals: towards an integrated model",
13 Boshuizen, H. P.A., Bromme, R. and Gruber, H. (Ed.s), *Professional learning: gaps and
14 transitions on the way from novice to expert*, Springer, Dordrecht, the Netherlands, pp. 207–
15 229.
16
- 17
18 Stemn, E., Bofinger, C., Cliff, D. and Hassall, M. E. (2018), "Failure to learn from safety incidents:
19 status, challenges and opportunities", *Safety Science*, Vol. 101, pp. 313–325,
20 DOI:10.1016/j.ssci.2017.09.018.
21
- 22
23 Suri, H. (2011), "Purposeful sampling in qualitative research synthesis", *Qualitative Research Journal*,
24 Vol. 11 No. 2, pp. 63–75, DOI:10.3316/QRJ1102063.
25
- 26
27 Tamuz, M., Franchois, K. E. and Thomas, E. J. (2011), "What's past is prologue: organizational
28 learning from a serious patient injury", *Safety Science*, Vol. 49 No. 1, pp. 75–82,
29 DOI:10.1016/j.ssci.2010.06.005.
30
- 31
32 Tynjälä, P. (2013), "Toward a 3-P model of workplace learning: a literature review", *Vocations and
33 Learning*, Vol. 6 No. 1, pp. 11–36, DOI:10.1007/s12186-012-9091-z.
34
- 35
36 Vastveit, K. R., Boin, A. and Nja, O. (2015), "Learning from incidents: practices at a Scandinavian
37 refinery", *Safety Science*, Vol. 79, pp. 80–87, DOI:10.1016/j.ssci.2015.05.001 .
38
- 39
40 Yap, K. and Choy, S. (2018), "Learning and praxis for workplace safety", *Journal of Workplace
41 Learning*, Vol. 30 No. 4, pp. 230–244, DOI: 10.1108/JWL-06-2017-0054.
42
- 43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
- 41 Zhao, B. and Olivera, F. (2006). "Error reporting in organizations", *Academy of Management Review*,
42 Vol. 31 No. 4, pp.1012-1030, DOI: 10.5465/amr.2006.22528167

Table I Basic characteristics of energy organisations

	Type of organisation	Global organisation size	Unit size
Company A	Petrochemical	70,000	1,000
Company B	Service and repair	30,000	20,000
Company C	Petrochemical	10,000	1,200

Journal of Workplace Learning

Table II Interview participants by company and job role

Company	Job type	Number of participants
A	Production front-line	6
A	Production management	6
A	Engineering front-line	2
A	Engineering management	4
B	Engineering front-line	9
B	Engineering management	2
C	Production front-line	10
C	Production management	6
Total	Front-line	27
Total	Management	18
Total	All	45

Table III Themes, codes and descriptions of learning aspects derived by thematic analysis

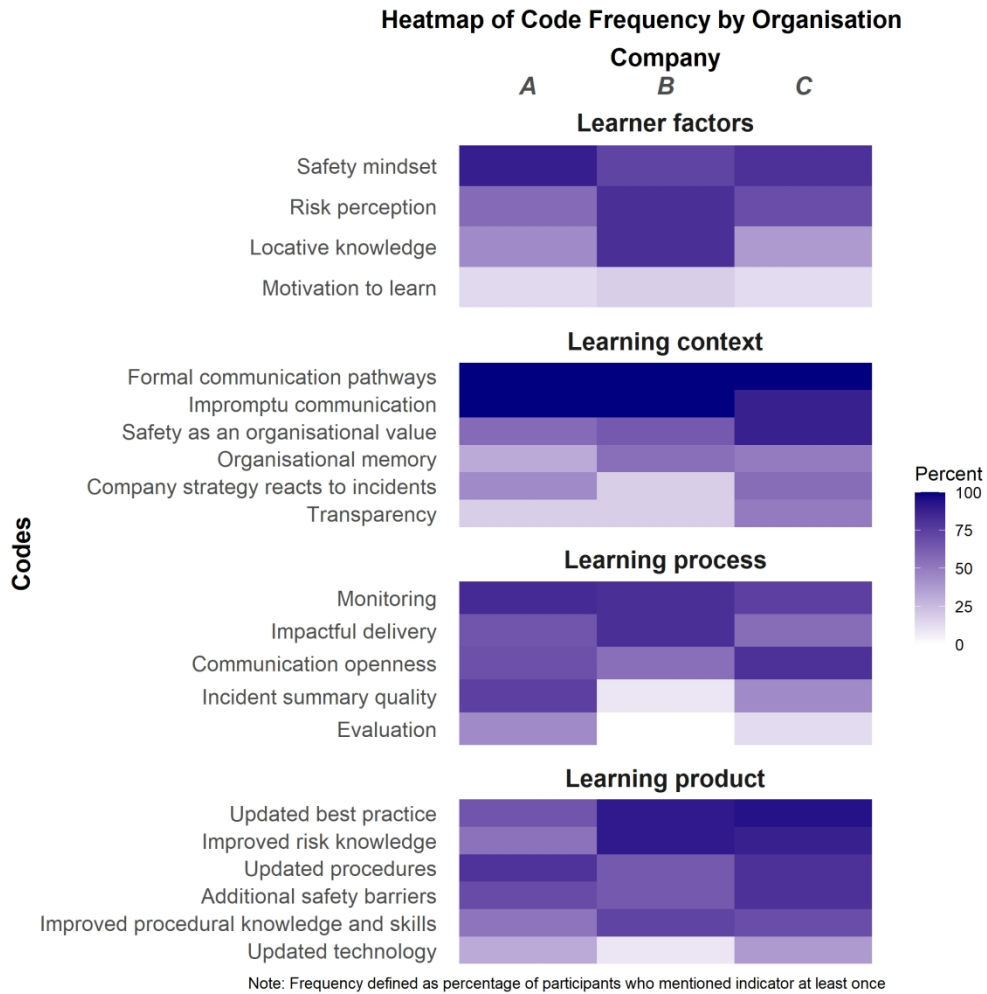
Theme	Code	Description	Descriptors
Learner factors	Motivation to learn	Workers show a willingness to improve themselves and the organisation	individual, formal, informal
	Locative knowledge	Workers know where to find information that they are looking for	individual, informal
	Risk perception	Workers have an accurate perception of how dangerous a task is	individual, formal, informal
	Safety mindset	Workers prioritise safety in their conduct	individual, formal, informal
Learning context	Formal communication pathways	The organisation has effective communication channels in place to allow targeted information on incidents to be exchanged	organisational, individual, formal
	Impromptu communication	Workers regularly communicate about incidents outside of scheduled meetings and formal emails	individual, informal
	Transparency	The organisation makes information and decision making rational available to all workers	organisational, individual, formal
	Safety as an organisational value	The organisation prioritises safety in its decisions, its internal structures and incentives reflect that	organisational, individual, formal
	Company strategy reacts to incidents	The organisation uses information on incidents to inform its strategies and priorities	organisational, formal
Learning process	Organisational memory	The organisation integrates incident-information into procedures, training and other artefacts	organisational, individual, formal, informal
	Communication openness	Workers at all levels can openly engage in two-way communication both within their team and with other colleagues	individual, formal, informal
	Incident summary quality	Workers receive high-quality information on incidents, both in content and format	individual, formal
	Evaluation	Organisations evaluate changes to assess if they were beneficial	organisational, formal
	Monitoring	Organisations collect and analyse data on safety practices, incidents, and learning	organisational, formal
Learning products	Impactful delivery	The creators of incident summaries deliver them in a way that engage workers and the contents are seen as relevant by workers	individual, formal
	Updated best practice	Workers update how certain tasks are carried out, but official procedures are not updated	organisational, formal
	Updated official procedures	The organisation updates official instructions on how tasks are carried out	organisational, formal
	Updated technology	The organisation introduces new technology to do an existing task	organisational, formal

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46

Additional safety barriers	The organisation adds an extra layer of safety assurance, e.g., a new checklist	organisational, formal
Improved procedural knowledge and skills	Workers have deeper knowledge of processes, including reasons behind approaches	individual, formal, informal
Improved risk knowledge	Workers have more knowledge of hazards, e.g., chemicals	individual, formal, informal

Journal of Workplace Learning

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



Frequency of participants who mentioned each code by organisation

508x508mm (118 x 118 DPI)