Chapter 7
On Nurses' Learning from Errors at Work

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7.1 Introduction

Learning from errors is a way of learning at work that receives increasing attention in workplace learning research (Bauer, Gartmeier, & Harteis, 2012; Wuttke & Seifried, 2012). Many scholars have argued that errors – although undesirable events – can be important sources of professional learning (Collin, Paloniemi, & Mecklin, 2010; for an overview, see Harteis & Bauer, 2014). Therefore, research on learning from errors seeks to address pertinent questions concerning how errors can be conceptualized, what errors are relevant for learning, how the learning process can be modeled and investigated empirically, what conditions support learning from errors, and how outcomes of learning from errors can be assessed.

In this chapter, we will summarize several of our studies that investigated processes and conditions of learning from errors at work in hospital and elder care nursing. Nursing is a profession that has gained a lot of attention by researchers with interest in professional development and workplace learning. Next to the societal importance of nursing, the knowledge-intensive and dynamic nature of this field of work makes it particularly interesting for researching continuing professional development (CPD) and workplace learning (Pool, Poell, & ten Cate, 2013; Valleala, Herranen, Collin, & Paloniemi, 2015). Learning from errors has a particular relevance in this field, because quality management and patient safety are key issues in health care and learning from errors may contribute to reducing the probability that specific errors reoccur (Tucker & Edmondson, 2003). Following the stated issues of

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research on learning from errors, we will summarize our studies in relation to the following questions:

1. What are examples of knowledge- and rule-based errors in hospital and elder care nursing that may serve as starting points for learning?
2. What are relevant learning activities to engage in after errors?

To answer these two questions, we will elaborate on the theoretical background of different types of errors and learning activities at the workplace. Moreover we will show examples of knowledge- and rule-based errors and related learning activities which we collected in interview studies with experts in both domains.

3. Under what conditions do nurses engage in such error-related learning activities?

Concerning this third question, we suggest a model of individual and organizational conditions that may foster or hinder error related learning activities at work. We developed and tested this model in two studies in hospital and elder care nursing.

Below, we will elaborate on nursing as a profession with high demands for human resource development including CPD and workplace learning. In this regard, we will highlight the potential contribution of learning from errors. Next, we present theory and evidence from our studies to respond to the three research questions. We will close the chapter with drawing conclusions on how nurses' learning from errors may be supported.

7.2 Background: Nurses' Work and the Importance of Learning from Errors

Nurses face a dynamic field of work requiring continuous learning to update their professional knowledge and competences (Skår, 2010). As in other health care professions, nurses' work is characterized by frequent changes in professional knowledge, procedures, methods, and standards (Pool et al., 2013; Tynjälä, 2008; Valleala et al., 2015). Hospitals and nursing homes experience increasing pressure because of the demographic change and ageing population, public expectations, and the introduction of new technology (Aiken et al., 2012). Moreover, nursing practice varies by different organizational conceptions (e.g., functional vs. primary nursing; Manthey, 2002) which involve differences in nurses' responsibilities, work activities, and professional collaboration. Finally, the nursing workforce structure seems to be changing, e.g. in age (Pool et al., 2013), but also in terms of qualifications (Collins & Hewer, 2014). More and more, the occupational field of nursing is moving from a vocation to a profession, including a transition to higher education.

With such rapid changes, CPD is needed for nurses to maintain and develop their knowledge and skills (Spouse, 2001). "Although the principles of lifelong learning and professional development have always been a part of nursing, the meaning of learning at work has grown even more in changing health care organizations due to

changing and developing knowledge, technology, content of work and organization, and procedures" (Lammintakanen & Kivinen, 2012, p. 36). Therefore, thinking about and investigating nurses' professional learning and development requires taking a broad perspective on CPD that includes individual learning activities at work and learning through work (Pool et al., 2013; Tynjälä, 2008). That is, in dynamic fields of work such as nursing, professional learning cannot be considered as restricted primarily to traditional (often classroom-based) forms of initial and continuing professional training. Instead, learning activities that are embedded in daily work seem at least equally important for maintaining and developing nurses' professional competence. Though learning through work can occur in many forms (e.g. Billett, 2004; Tynjälä, 2008, 2013), we believe that errors are important in this regard. Errors are salient occasions that may give reasons to question current practices (as well as the underlying dispositions) and suggest a need to revise and improve (Bauer, 2008). So, they can be important triggers for individual and social learning activities at work.

The discussed features of nurses' work, however, also make learning from errors a particular challenge. Frequent changes and requirements to adapt increase the likelihood of errors to occur, making error management and learning from errors especially relevant (Cramer, Pohlabeln, & Haberman, 2013; Van Dyck, Frese, Baer, & Sonnentag, 2005). Indeed, recent studies indicated that high risk for patients' safety may arise from how care is provided in hospitals and retirement homes (Cramer et al., 2013; Dubois et al., 2013). Because errors may lead to serious adverse effects on a patient's health, they are a delicate topic in health care pertaining to quality management and patient safety (Collin et al., 2010). Health care organizations are typically work environments in which high-level, accurate performance is crucial and services are supposed to be delivered while upholding high standards of quality and professionalism (Aspden, Corrigan, Wolcott, & Erickson, 2004). Nurses – as the largest group of professionals in health care – have a central role in this regard. Additionally to their growing importance for patient care, nurses have to take increasing responsibility for ensuring the quality of care services, for example by planning, assessing and evaluating patients' needs (Mendes & Fradique, 2013). Therefore, nurses' activities at work constitute major contributions to implementing strategies of quality and risk management in health care organizations, including the identification and prevention of errors.

For the reasons presented above, dealing with errors in a learning-oriented way has been subject to intensive debate in health care. Error management and learning from errors are increasingly recognized as tools of quality management and securing patient safety (Pfeiffer & Wehner, 2012). Such error-related learning processes can occur and be analyzed at the individual, the team, and the organizational level (Russ-Eft, Watkins, Marsick, Jacobs, & McLean, 2014). At the organizational level, recent developments have aimed at the introduction of a patient safety culture including perceptions, behavior, and competences of individuals and groups to determine an organization's commitment, style, and proficiency in safety management (Putz, Schilling, & Kluge, 2012). Tools for anonymous critical incident reporting have been introduced to foster such a culture and organizational learning from errors (Pfeiffer & Wehner, 2012; Zhao, 2011). Moreover, a shift from

a culture in which individuals are blamed for errors towards a culture offering the opportunity to use errors to improve the system and prevent harm has been welcomed (e.g., Bonner, Castle, Perera, & Handler, 2008). Regarding the team level, one has to bear in mind that the work structure in nursing requires nurses to work together in teams. To ensure high standards of quality and professionalism and to accomplish work tasks effectively, they have to exchange information and develop strategies in social cooperation (Timmermans, Van Linge, Van Petegem, Elseviers, & Denekens, 2011). Nurses' engagement in social learning activities is important for enabling team learning processes. Such team learning processes can be seen as a continuing effort of knowledge sharing, or providing and receiving feedback (Edmondson, Dillon, & Roloff, 2007; Timmermans, Van Linge, Van Petegem, & Denekens, 2012). Finally, on the individual level, learning can occur in the form of reflections on causes of errors or the development of new or revised action strategies to avoid errors in the future (Bauer & Mulder, 2007). As discussed in the next section, such individual and collective processes of learning from errors seem to be narrowly intertwined.

In summary, whereas a lot of research on quality management initiatives focus on the organizational level, there is a growing interest in conditions under which nurses learn from errors they encounter in daily work and how they apply learning activities to do so (Abusalem & Coty, 2011; Bauer & Mulder, 2008; Cannon & Edmondson, 2001). Research on this could improve our understanding of how learning from errors contributes to the development of knowledge and skills within professional contexts, but also contribute to issues of organizational learning and development of strategies (Edmondson, 2004). In the following section we summarize our studies with a focus on individual learning from errors and also indicate how this extends to the team level.

7.3   Nurses' Learning from Errors at Work

7.3.1   What Are Examples of Knowledge- and Rule-Based Errors and Relevant Activities to Learn from Them?

Understanding how learning from errors can contribute to nurses' professional development requires clarifying conceptually and empirically what is meant by *error* and how the learning process can be modeled. In this section, we sketch our theoretical perspective on these questions and summarize the studies in which we applied it to hospital and elder care nursing.

Errors can be defined as individual actions or decisions that result in a deficient deviation from a desired goal and that endanger the attainment of dependent goals (Reason, 1990). An inadequate action establishes a critical situation in which the achievement of the desired goal is endangered (Bauer & Mulder, 2007). Subsequently, the error may be detected and corrected, or defences in the environment may work. Otherwise, an adverse outcome concerning the patients' health may occur. For

example, consider a nurse preparing a patient for a colonoscopy. A mistake in choosing an appropriate dosage of laxative for the specific patient may result in the patient's bowel not being entirely empty for accurate examination. The mistake creates a critical situation because – even though the goal is endangered – no adverse event has occurred, yet. If the medication was cross-checked by another nurse or physician, the error might be detected and corrected. Next to this generic definition, types of errors on different levels of cognitive action regulation can be distinguished: slips, lapses, and knowledge- and rule-based errors (Reason, 1990). Whereas slips and lapses result from problems in unintentional memory and attention processes, knowledge- and rule-based errors concern the action plan and result from problems in the application of knowledge and rules. The latter type of error involves several sub-classes, such as the misinterpretation of a situation and subsequently making a wrong decision. Medication errors are typical examples for slips and lapses in health care (e.g. mixing up medications; Kohn, Corrigan, & Donaldson, 1999). Examples of knowledge- and rule-based errors are given in Table 7.1. This differentiation of types of errors is important because several authors have argued that knowledge- and rule-based errors provide a particular potential for learning (Keith & Frese, 2005). These types of errors enable individuals to deliberately revise their knowledge and practice through engagement in learning activities.

By engagement in learning activities, we refer to a self-organized effort to improve performance (Tynjälä, 2013). Drawing upon experiential learning theory (Kolb, 1984), error-related learning activities can be modeled to comprise the reflection of potential causes after the experience of an error, considering ways to prevent them in future, and experimenting with and implementing the new or revised strategies (Bauer & Mulder, 2007). Each of these activities can be performed individually or in social cooperation with others at work. For a number of reasons learning activities performed in social interactions (i.e., joint analysis of causes and development of new action strategies together with peer colleagues or supervisors) seem particularly relevant to learning from errors (Bauer et al., 2012). Theoretically, this is consistent with the finding that interaction with other people constitutes one of the most significant sources of learning at work (Billett, 2004). Practically, as mentioned above, the structure of nurses' tasks frequently requires team work which is facilitated by shared knowledge. Hence, from a quality and patient-safety perspective it seems desirable that more than a single nurse should learn from an error. Communication and exchange can foster the development of shared knowledge and understanding of errors, as well as of solutions and strategies with which to handle them (Cannon & Edmondson, 2001; Van Dyck et al., 2005). In line with this, there is evidence to suggest that social learning activities are crucial in nurses' learning through work and CPD (Bjørk, Tøien, & Sørensen, 2013; Skår, 2010; Timmermans et al., 2011). Therefore, engagement in social learning activities after errors can be regarded as beneficial for learning at both individual and team levels.

In our research, we investigated the nature of errors and error related learning activities in the field of nursing. We conducted two interview studies with experts in hospital nursing (Bauer & Mulder, 2007) and elder care nursing (Leicher, 2011; Leicher, Mulder, & Bauer, 2013), in which we elicited typical examples of knowl-

Table 7.1 Categories and examples of knowledge- and rule-based errors in hospital nursing and elder care nursing

Category	n/ex
1. *Hospital nursing*	*(N=10)*
Inadequate interpretation of a situation	6/7
Critical values on a screen are not cross-checked with the overall physical state of the patient, so that an inadequate or unnecessary intervention is applied	
Non-application of a new or up-to-date method (i.e. non-application of a correct rule)	4/4
Instead of a new or up-to-date method an old one is applied, because the nurse is not used to the new one, or does not feel confident enough in the application, and also does not dare to ask	
Application of out-of-date "rituals" and methods, although they have been proven to have adverse effects (i.e. application of a bad rule)	3/5
Wrong treatment of bedsore: applying ice and blowing dry	
Lack of knowledge about current guidelines and standards (i.e. deficient knowledge)	3/4
Wrong preparation of a patient for an operation because the nurse has insufficient knowledge about current standards	
Wrong application of a method because of lack of knowledge (i.e. wrong application of a good rule)	3/5
Errors in the preparation of a colonoscopy may mean that the patient's bowel is not entirely empty and the examination cannot take place. This results from a lack of knowledge in the individual dosage of laxative for a specific patient	
Not asking someone experienced in case of uncertainness	3/3
Wrong estimation of the risk surrounding a situation and not asking more experienced colleagues for help	
Errors in interpersonal relationships	2/2
Giving up the professional distance from patients	
Not to challenge orders from a supervisor or a physician	1/1
2. *Elder care nursing*	*(N=3)*
General deficiencies in knowledge (i.e. deficient knowledge)	3/9
Failing to recognize a danger of bed sore	
Planning failures of nursing (i.e. non appliance of a correct rule)	2/3
Omitting necessary nursing measures	
Lack of knowledge about current guidelines and standards (i.e. deficient knowledge)	1/1
Treating patients with dementia	
Inadequate interpretation of a situation	1/1
Consulting a physician too late or too early	
Errors in interpersonal relationships	1/1
Not showing empathy in conversations with relatives	

Note. Part (1) is reprinted from Bauer and Mulder (2007) with permission from Blackwell Publishing/Wiley; part (2) is based on Leicher (2011); *n* number of participants mentioning an error in the respective category, *ex* number of given examples within the category; sub-categories of knowledge- and rule-based errors (Reason, 1995) are indicated where adequate in parentheses after the respective category names

Table 7.2 Categories and examples of error related learning activities in hospital nursing

Category	n/ex
1. ***Non-formal learning***	–/28
(a) *Learning in social exchange*	–/16
Exchange with colleagues	7/8
Exchange with more experienced colleagues (6)	
Asking colleagues for advice or help	
Mutual control and critique	
Exchange with the supervisor	4/5
Discussing the issue with the supervisor (2)	
Asking the supervisor for help (2)	
Root cause analysis together with the supervisor	
Open discussion within the team	3/3
Open discussion in team meetings, so that all team members have the opportunity to learn from the error (3)	
(b) *Individual reflection*	–/6
Root cause analysis	4/4
(Self-) reflection about possible causes of the error (4)	
Reflection on alternative action strategies	2/2
Reflection on what has do be done differently the next time (2)	
(c) *Deliberative self-regulated learning*	4/6
Closing gaps in one's professional knowledge by oneself and taking care that one is up-to-date (3)	
Reading professional journals (2)	
Updating one's knowledge about current standards	
(2) ***Formal learning***	5/6
Attending training and professional development courses (5)	
Identifying one's need for further training	
(3) ***Emotional reaction***	4/4
Emotional conditioning through the error (2)	
Remaining in a state of brooding	
Talking to colleagues in order to salve one's conscience	

Note. Table reprinted from Bauer and Mulder (2007) with permission from Blackwell Publishing/ Wiley; *n* number of participants (of *N* = 10) mentioning a learning activity in the respective category, *ex* number of given examples within the category, *numbers in parentheses* number of participants mentioning the same activity

edge- and rule-based errors. Experts were identified based on their long professional experience (>10 years), a supervisory position, and peer-assessed as being highly qualified. We asked the participants to describe concrete examples of knowledge- and rule-based errors which occur in nursing practice according to their experiences. In the hospital nursing study, we asked the participants additionally to identify activities that a person would have to engage in after an error, such as the one(s) they had just described, in order not to repeat a similar error again (i.e., learning activities). Tables 7.1 and 7.2 summarize and classify the experts' statements.

Concerning our first research question, the exemplary errors provided by the experts draw a rich picture of knowledge- and rule-based errors in both domains of nursing. They reflect a broad range of nurses' responsibilities in planning, organizing, and implementing nursing activities. Across both domains, the experts assigned errors due to the inadequate interpretation of a situation, deficiencies in knowledge, and the non-application of correct rules, a relatively high importance (cf. Table 7.1). Overall, the findings from the interviews are largely consistent with the theoretical assumptions about sub-classes of knowledge- and rule-based errors (Reason, 1990; cf. Bauer & Mulder, 2007). Though the examples provided cannot be considered representative for errors in nursing, the findings are useful for thinking about relevant learning activities as well as for identifying potential needs for CPD. For example, the issue of prophylaxis and treatment of bed-sore (decubitus) was a prevalent concern in many interviews.

Regarding the second question on learning activities after an error at work, the experts' answers hinted at the relevance of engaging in systematic reflection on causes of an error as well as developing revised action strategies. These findings are consistent with modeling error related learning activities as an experiential learning cycle (Bauer, 2008; Bauer & Mulder, 2007). Moreover, the experts stressed the role of social exchange as crucial for these learning activities. This finding adds to the evidence base that social learning activities are particularly relevant for learning from errors (Harteis, Bauer, & Gruber, 2008) and in the domain of nursing (Bjørk et al., 2013; Skår, 2010; Timmermans et al., 2011). An interesting point here is that the experts' statements referred to exchange both with peer nurses and supervisors (cf. Table 7.2). Given that the interviewed experts all had a supervisory position, this perspective seems plausible. The hierarchical nature of the relationship to supervisors and the inherent power imbalance, however, may complicate open exchange about errors with supervisors. Indeed, several studies have emphasized the importance of supervisors' characteristics and behavior for dealing errors at work in a learning-oriented way (unsympathetic and unjust vs. helping and protective reactions, espoused vs. enacted attitudes, etc.; for an overview, see Bauer & Mulder, 2008). Hence, for organizational development initiatives, it can be concluded that the development of an organizational culture that supports a learning-oriented, open discussion of errors seems a necessity (Edmondson, 2004).

7.3.2   Under What Conditions Do Nurses Engage in Error-Related Learning Activities?

In the previous section, we conceptualized learning from errors based on experiential learning theory and our interview studies. Moreover, we emphasized that the engagement in social learning activities (ESLA) – i.e., jointly reflecting with colleagues on potential causes of errors and ways to prevent them in future – seems particularly relevant in nursing. A natural follow-up question is under what
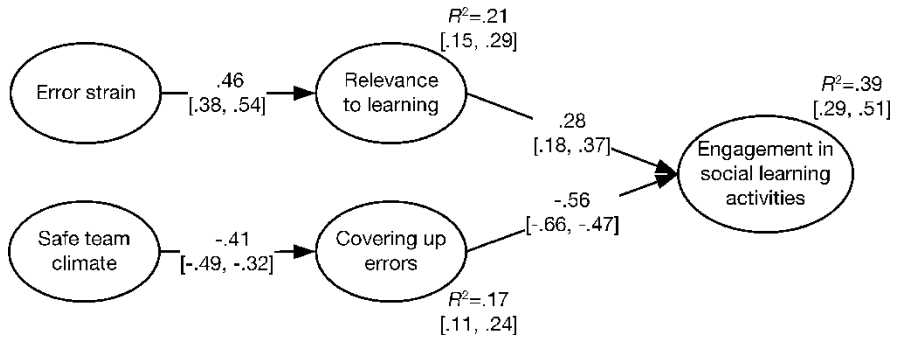
Fig. 7.1 Standardized estimates [95 % confidence intervals] of the meta-analytic structural equation model for nurses' engagement in social learning activities synthesizing the models in Bauer and Mulder (2013) and Leicher et al. (2013); model fit indices: $\chi^2(83) = 225.03$, $p < 0.001$; RMSEA = 0.063, CFI = 0.993, TLI = 0.992, SRMR = 0.087; indirect effects: error strain $\beta = 0.13$ ($p < .05$); safe team climate $\beta = 0.23$ ($p < .05$); measurement part of the model omitted

conditions nurses engage in such social learning activities after an error at work. In this section, we will summarize theory and evidence from two surveys in hospital nursing (Bauer & Mulder, 2013) and elder care nursing (Leicher et al., 2013) regarding this question.

Research suggests that the perception of a positive cost-benefit balance is required for reporting errors (Zhao & Olivera, 2006). The benefit of engaging in social exchange after an error can be seen in the potential learning gain and the possibility to avoid similar errors in future. In contrast, subjective cost can occur in the form of fear of repercussions and loss of face if admitting an error. More tangible costs can be at stake in health care, too, e.g. in the form of disciplinary or legal proceedings. Based on this idea, two strands of factors that may drive nurses' ESLA can be distinguished: (1) the nurse's individual reaction and appraisal of the error situation as relevant to learning (benefit) and (2) the nurse's perception of a trustful and psychologically safe social climate at work that permits disclosing an error with reduced psychological cost. Drawing on these considerations, we developed a mediation model of nurses' engagement in ESLA that includes hypotheses about relationships among four relevant variables relating to these two strands (Fig. 7.1). Focusing on the individual perspective, *error strain* refers to nurses' emotional reaction to having committed an error, and in particular to negative emotions, like anger, fear or shame (Rybowiak, Garst, Frese, & Batinic, 1999). Such emotions have to be regulated (Keith & Frese, 2005; Rausch, 2011; Zhao, 2011) and may affect learning. A particular relevance for learning may be felt if an error situation is perceived as emotionally stressful, because this may create a subjective need not to repeat the error (Oser & Spychiger, 2005). Hence, the second variable on level one is the estimation of an error as being relevant to learning (*relevance to learning*). This subjective relevance refers to the cognitive interpretation of an error as a starting point for inquiry about underlying causes, and can be seen as taking a learning orientation toward an error. Regarding the perception of the social context, the

model concerns the anticipated reaction of others at work to reporting and discussing an error. On this perspective, the model contains the perception of a safe and trustful climate in the work team (*safe team climate*). A safe team climate characterized by interpersonal trust, mutual respect and the possibility to openly address errors may alleviate potential concerns about psychological costs and, thus, facilitate an open discussion of errors within the social context of a team (Cannon & Edmondson, 2001). Therefore, a safe team climate may reduce the individual tendency of *covering up errors*, a motivational orientation that may prevent communicating with others about an error (Rybowiak et al., 1999).

In summary, the described model poses two mediation paths on nurses' ESLA representing the two mentioned perspectives, respectively. Concerning the individual reaction, the subjective learning relevance mediates the effect of negative emotions associated with the error situation (i.e., error strain) on ESLA. Concerning the perceived social context, the tendency to cover up errors is a mediator between the perception of a social team climate and ESLA. In our research, we developed and tested the mediation model in a study on hospital nursing (Bauer & Mulder, 2013) and then replicated the findings in another study with elder care nurses (Leicher et al., 2013).

Both studies were cross-sectional surveys in which nurses answered questions with regard to vignettes describing error examples. Vignettes are short, descriptive stories of an incident of practice presented to elicit rich but focused opinions and reactions to its content (Finch, 1987). By using the vignette technique, we investigated the nurses' intended learning activities with regard to specific error situations rather than their general assumptions about errors and learning from them (Bauer & Mulder, 2007; Mulder, 2015). The vignettes had been created on the basis of the findings on typical nursing errors described in this chapter. The focused type of error was the misinterpretation of a nursing situation and the subsequent making of a wrong decision. The questionnaires started by presenting the vignettes. The nurses were asked to choose one of them, imagine the situation vividly, and to then rate their intention to engage in joint reflection with colleagues on potential causes of the error and the development of strategies to avoid similar errors in future. In both studies, the nurses estimated the error vignettes as authentic and relevant. Moreover, we found the outcomes concerning nurses' ESLA independent of the individually chosen error vignettes.

To test the variable relationships hypothesized in the mediation model, we used structural equation modeling (SEM) in both studies. For the purpose of the present chapter, we synthesized the findings from both models using meta-analytic SEM (MASEM; Cheung & Chan, 2005). Though meta-analysis is frequently believed to be restricted to large-scale research syntheses, "combining even two studies can give a useful increase in precision" (Cumming, 2012, p. 184; cf. Valentine, Pigott, & Rothstein, 2010). Because structural equation models typically provide less than perfect fit to the data in each individual study, MASEM can help to reduce bias. Hence, the added value of this integration lies in providing more precise and trustworthy estimates as compared to the individual studies. For the reader's convenience, technical details of the MASEM analysis are given in the appendix.

Concerning question three posed in the beginning of the chapter (Under what conditions do nurses engage in such error-related learning activities?), the findings demonstrate the relevance of the individual reaction to an error and the perception of a safe social climate at work and clarify the relationship of these variables with nurses' ESLA. As can be seen from the estimates in Fig. 7.1, the results of both studies corroborate the assumptions "(…) that (1) the estimation of an error as relevant to learning depends on the amount of emotional strain suffered from an error and, in turn, predicts engagement in social learning activities; moreover, […] (2) the tendency to cover up an error depends on the perception of a safe team climate and, in turn, predicts engagement in social learning activities" (Bauer & Mulder, 2013, p. 109). That is, emotional strain felt as reaction to having committed an error relates to a subjective need to address the putative causes of the error and therefore motivates ESLA (Oser & Spychiger, 2005; Rausch, 2011; Zhao, 2011). Moreover, the findings are consistent with the assumption that taking the risk of communicating an error to others at work seems to require the perception of a safe social environment which reduces the expectation of repercussions or punishment (Edmondson, 1999; Zhao & Olivera, 2006). These findings are in line with the discussed proposal that reporting errors and discussing them with colleagues depends on a positive subjective cost-benefit balance (feared social repercussions vs. learning relevance; Zhao, 2011). In terms of practical significance, the effect sizes yielded in the MASEM analysis indicate that the assumed relationships are at least medium to large. Overall, the variables in the model explain 39 % Variance in ESLA. In particular, the mediated effect of a safe team climate on ESLA seems substantial, given its indirect nature.

An interesting finding is that the two discussed strands (i.e., mediation paths) of the model seem to work independently from each other. In both studies the estimated emotional reaction and subjective relevance of errors to learning were uncorrelated with the perception of a safe team climate and the tendency to cover up errors. This may be surprising, because one might assume that a psychologically unsafe team climate would go along with increased error strain. The findings, however, suggest that factors concerning individual reaction to errors and factors concerning the social context constitute different aspects when it comes to the decision whether to discuss an error with colleagues, or not. This observation is relevant for quality management to raise employees' preparedness to report and discuss errors. Apparently, such interventions need to take into account both levels separately.

Finally, the findings show that the mediation model applies to both domains of nursing. Descriptively, the results in the elder care nursing study were completely consistent with the hospital nursing study in terms of the effects' direction and statistical significance (Leicher et al., 2013). The MASEM analysis added further evidence to this by showing that the pattern of relationships among the variables, indeed, does not differ substantially across the studies (see stage one of the MASEM analysis in the appendix). This indicates that – regardless of the differences in tasks and work structure between hospital and elder care nursing – factors that are related to ESLA work in a comparable way in both domains. Evidence from recent studies in the chemical industry (Seifried & Höpfer, 2013) and in retail banking (Leicher &

Mulder, 2016) indicates that the mediation model may even have a broader applicability.

7.4 Conclusion

In this chapter, we gave an overview of qualitative and quantitative studies on learning from errors at work in hospital and elder care nursing. These studies addressed three questions about important errors and related learning activities, as well as about conditions for engagement in social learning activities. The findings, first, provided a rich picture of relevant classes of knowledge- and rule-based errors (Reason, 1990; cf. Bauer & Mulder, 2007). As discussed, these types of errors have been claimed to be particularly relevant for learning (e.g., Keith & Frese, 2005). Second, the expert interviews contributed to the validity of the suggestion to model learning from errors as experiential learning cycle. Moreover, they add to existing claims that social learning activities are important for learning from errors in general (Harteis et al., 2008) as well as in the domain of nursing (Bjørk et al., 2013; Skår, 2010; Timmermans et al., 2011, 2012). The importance of such learning activities can be substantiated both from a theoretical and a practical perspective, because they enable learning processes on the individual level but also may extend it to the collective level. Third, the MASEM analysis, which integrated findings from two surveys in hospital and elder care nursing, demonstrated that ESLA is related to the individual reaction to an error and the perception of a safe social climate at work. Specifically, the relationship between error strain and ESLA seems to be mediated by the perception of an error as relevant to learning, while a safe team climate predicts ESLA through a motivational tendency to cover up errors (Bauer & Mulder, 2013; Leicher et al., 2013).

In interpreting these findings, at least three limitations should be considered. First, the qualitative and cross-sectional designs prohibit taking the results as evidence for causal relationships. That is, though causal connections among the investigated variables may be assumed for theoretical reasons, the present data cannot corroborate them. Second, the self-report nature of our measures may be criticized. To constrain self-report biases, we used the described vignettes-approach in the survey studies. Third, our studies focused specifically on knowledge- and rule based errors. Further research should also include other types of errors like slips and lapses which also occur in real work life. Comparing how different kind of errors lead to differential learning activities could advance our understanding and provide further implications for practice.

Though the focus of our chapter has been on learning from incidental errors, we close with some broader implications and recommendations for organizational development as well as for nurses' CPD. Concerning organizational development, as mentioned, our findings are consistent with calls to establish a learning-oriented culture that facilitates reporting and open discussion of errors in hospitals and elder care institutions (Aspden et al., 2004; Edmondson, 2004). For achieving this,

Harteis and Bauer (2014) recommended a strategy that integrates three types of efforts concerning (a) organizational safety, risk and quality management to estimate the risk of occurrence of certain errors as well as measures to reduce their probability; (b) organizational learning from errors by means of systematic collection and analysis of errors and critical incidents with the purpose of revising and improving current organizational structures and processes; and (c) team and individual efforts to analyze own errors and their potential causes, as well as the development of strategies to avoid similar errors in future. The integration of these efforts aims at reconciling the seemingly disparate or even contradictory goals of error prevention, error management, and learning from errors both at the individual and collective levels.

Regarding nurses' CPD, the potential of errors for learning extends to more traditional forms of training. We consider two exemplary goals, here: increasing nurses' knowledge about typical errors in their field of work, and building up their skills in managing occurring errors efficiently. Regarding the former, working on authentic cases of typical errors can enhance (future) professionals' awareness of what errors frequently occur in their field of work. This knowledge may help them to anticipate and avoid such fallacies. Moreover, scaffolding learners' reflection on errors and their causes can assist them in acquiring the skills required to systematically learn from errors. Hence, exploring and analyzing authentic error cases, elaborating their general and specific causes, as well as action strategies to handle them may contribute to error prevention and improve task performance. Relevant errors for these purposes can come from academic research – such as the collection of error cases that we developed from our interview studies – as well as from analyses of critical incident reporting systems. Regarding the second goal, vocational education and training as well as CPD should support learners in developing and applying appropriate strategies for managing errors efficiently. That is, professionals should have automatized strategies to detect errors, correct them if possible, and to contain their adverse consequences. Because errors may impose severe stress and time pressures, having developed such skills is necessary for responding quickly and efficiently to the situation (Zapf, Frese, & Brodbeck, 1999). For both stated goals training simulations can be helpful because they provide explicit opportunities to explore errors in a safe context. Such simulations already constitute a major element of professional learning in several fields of work (e.g. aviation) and become increasingly important in health care as part of workers' continuing professional education.

Appendix

MASEM is a recent development in the field of model-based meta-analysis aiming at the integration of findings from structural equation models (Cheung & Chan, 2005). For synthesizing the findings from Bauer and Mulder (2013) and Leicher et al. (2013), we used the two-stage structural equation modeling (TSSEM) approach

to MASEM (Cheung & Chan, 2005). This approach proceeds in two steps. In stage one, the homogeneity of the correlation matrices of the individual studies' variables is tested using multiple group SEM (i.e., with studies as groups). If a model imposing equality constraints on the correlation matrices across studies fits the data well, as judged by SEM fit indices, then there is sufficient evidence of homogeneity. In that case, a pooled correlation matrix can be estimated across the studies. In stage two, this pooled correlation matrix is used to fit the substantive model.

We used the metaSEM package version 0.9–1 (Cheung, 2015) in the **R** statistical environment version 3.1.2 (R Core Team, 2014) to fit the MASEM. In stage one, a fixed effects model was used because only two studies entered the analysis.

The results of stage one indicated sufficient homogeneity of the two studies' correlation matrices ($\chi^2(105) = 213$, $p < 0.001$; RMSEA = 0.069, CFI = 0.970, TLI = 0.940, SRMR = 0.059). In the stage two analysis we specified the model as depicted in Fig. 7.1. To avoid clutter, the measurement part of the model is omitted in the figure. ESLA is a second-order factor comprising the social learning activities *general cause analysis*, *specific cause analysis* and *development of new strategies* as first order factors (cf. Bauer & Mulder, 2013). Fit indices from the stage two analysis indicated acceptable fit for the mediation model (see Fig. 7.1). First order factor loadings range between 0.53 and 0.99, second order factor loadings between 0.67 and 0.74.

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