Vocations and Learning (2011) 4:25–39
DOI 10.1007/s12186-010-9047-0

ORIGINAL PAPER

Error Orientation and Reflection at Work

Stefanie Hetzner · Martin Gartmeier · Helmut Heid · Hans Gruber

Received: 11 February 2009 / Accepted: 1 September 2010 /
Published online: 1 October 2010

Abstract Reflection on events at work, including errors is often as a means to learn effectively through work. In a cross-sectional field study in the banking sector, we investigated attitudes towards workplace errors (i.e. error orientation) as predictors of reflective activity. We assumed the organisational climate for psychological safety to have a mediating effect. The study participants were 84 client advisors from the retail banking departments in branches of a German bank. The client advisors' were being affected by a range of changes in their workplaces at the time of the data collection. This situation afforded these workers opportunity for learning but also involved the risk of error by these staff. Regression analyses identified that error competence and learning from errors were significant predictors of reflection. The results confirmed the mediating role of psychological safety on the association between attitudes towards errors and reflective working behaviour.

Keywords Error orientation · Psychological safety · Reflection · Retail banking · Workplace change

In the course of growing interest in how employees manage to update and develop their skills and knowledge through workplace learning, scholars have stressed the importance of reflection at work (Boud et al. 2006; Ellström 2006; van Woerkom 2003). Reflection is basically described as a cognitive activity that individuals perform to examine retrospectively incidents encountered or activities performed (Boud et al. 1989). More specifically, studies have found that reflection relates directly to the development of employees' competence (Gartmeier et al. 2008; Strasser and Gruber 2005), job satisfaction (Berg and Hallberg 2001) and career success (Marienau 1999).

S. Hetzner (✉) · H. Heid · H. Gruber
Institute of Educational Science, University of Regensburg, 93040 Regensburg, Germany
e-mail: stefanie.hetzner@paedagogik.uni-regensburg.de

M. Gartmeier
School of Education, Technical University of Munich, 80799 Munich, Germany

Although reflection in general is a well-researched concept, little is known about the predictive quality of individuals' attitudes about using errors for reflection for learning at work. Errors at work are incidents that interrupt the workflow, cause stress, and pose challenges to employees' competencies. Nevertheless, scholars emphasise that errors can serve as opportunities for learning and, thus, foster development of competence and organisational innovation (Bauer and Mulder 2007; Cannon and Edmondson 2005). Drawing upon existing theoretical accounts, attitudes towards errors ("error orientation") forms a central concept in this respect: "If a company has a more positive attitude towards errors, it can be more action-oriented, innovative, and experimental" (Rybowiak et al. 1999, p. 528). To illuminate and critically appraise the mechanism behind the beneficial effects of positive attitudes towards errors, here we investigate the association of attitudes towards errors with reflection at work.

Because this association is investigated in a workplace setting, it is proposed that this relationship also needs to be understood from a social perspective, otherwise, crucial consequences of employees working mainly in collaboration would be neglected (Billett 2001). For instance, good relationships between colleagues facilitate opinion sharing, critical discussions, and the development of problem-solving strategies are likely to influence this association (Edmondson 1999). The quality of social relations at work thus may affect individuals' capacity for and willingness to engage in reflection. In addition, employees' attitudes towards errors may constitute a model in the social work environment as to how errors are treated. Thus, we expect social contextual factors to mediate the association between individuals' attitudes towards errors and reflective working behaviour.

To understand this association, we conducted a study in the retail banking departments in branches of a German bank. The banking sector provides an helpful field for study, as it nowadays comprises a dynamic field in which change is a permanent condition of work and this situation involves the risk of error (Raehalme 1999). Consistent with this concern, the workplaces of our study participants were affected by significant changes that had a range of consequences for their everyday work. The workplace changes pressed employees to adapt to new standards and tools for customer consulting and, thereby, to modify their work routines. In detail, the advisory concept was fundamentally modified, accompanied by the implementation of new advisory software. These changes brought about new work tasks and called for proactive work behaviour and participation. The employees had to develop new work processes in cooperation with their colleagues as well as in coordination with their supervisors. In order to cope successfully with the requirements made by these changes, the employees had to beware of emerging situations likely to cause errors as well as competencies for coping with such errors. Hence, a study of bank workers provides a rich opportunity to understand the relationship amongst changes at work and individuals' engagement in work and learning.

Theoretical Background: Reflection in the Workplace

Educational scientists in the field of workplace learning aim to identify effective strategies for individuals to meet the changing requirements of contemporary work.

Therefore, many scholars emphasise the importance of reflection at work for individual and organisational learning (Boud et al. 2006; Høyrup 2004).

Reflection is characterised as an introspective process that includes reviewing experienced phenomena, analysing causes and effects, and drawing conclusions for future actions (Boud et al. 1989; van Woerkom 2003). Reflection represents an activity pursued with intent; emotions and cognition are closely interrelated and interactive (Boud and Walker 1991). Thus, reflection is an activity that allow individuals to exploit the learning potential of work-specific situations. It can foster the acquisition of experiential knowledge and the development of professional competencies (Gartmeier et al. 2008), which is important for both learning and sustaining the ability to become and remain a competent worker. One reason these outcomes are realised is that reflection leads to a deeper understanding of incidents and experiences. It can also contribute to successful mastering of new tasks and more informed appreciations of them. Accordingly, evidence shows that reflective activity is a key factor that supports learning from errors at work (Harteis et al. 2007). Bauer and Mulder (2007) developed a framework of error-related learning activities based on the experiential learning theory. The framework includes three phases: i) cause analysis, ii) the development of new work processes and strategies to avoid reoccurrence of the error, and iii) implementation of the new processes and strategies within the work context. Such a framework is useful for highlighting the multipart process that comprises learning through errors. As discussed below, attitudes towards errors relate closely to these error-related learning activities.

Some scholars regard reflection primarily as an individual cognitive process that is only marginally influenced by the social environment (Moon 1999). Others argue in favour of a shared and collaborative approach (Høyrup and Elkjaer 2006; Kim and Lee 2002). These scholars consider reflection an activity-oriented concept that comprises a strong social perspective. This perspective seems especially relevant in workplace settings. As cooperation and discussion are integral parts of everyday work, collective reflection is an important concept in today's working world (Nyhan 2006). If understood and practised in this way, reflection can potentially be a fruitful approach to workplace learning. It can lead to increased awareness of the surrounding conditions. Thus, it potentially can shape employees' daily work and learning. Relevant workplace conditions to promote such reflection likely include social relationships at work, leadership behaviour, and the usefulness of the services or products provided by the organisation (Anderson and Thorpe 2004).

It follows from the above that both the individual perspective and the social perspective are relevant to understanding the potential of reflection at work. On the one hand, reflection cannot be thought of without considering an individual's cognition. On the other hand, neglecting the influence imposed by the social environment upon individuals' reflection would provide an incomplete picture. Thus, our investigation of reflection at work focuses on the interplay between contextual factors (i.e. psychological safety) and individual factors (i.e. reflection, attitude towards errors).

Attitude Towards Errors and Reflection at Work

Positive attitudes towards errors are important preconditions for effective reflection at work. To illustrate this proposition, it is necessary to consider the role that errors

at work play within the discourse on workplace learning. Errors are defined as negative deviations from desired goals resulting from individual actions or decisions (Cannon and Edmondson 2005; Zhao and Olivera 2006). Hence, whether something is an error is seldom an objective feature of the phenomenon itself, but depends upon norms and criteria applied in the respective socio-cultural environment. For example, in a rather restrictive and bureaucratic culture, it might be seen as a severe interpersonal mistake to arrive 30 min late for a scheduled meeting, yet the same conduct might be judged totally differently in a more flexible, entrepreneurial workplace environment (Bauer 2008; Reason 1990). So, the situational variables have to be included.

Thus, a first prerequisite to learn from an error is to recognise it as an incident that deviates from expectations, intentions or standards. Although errors at work are undesirable and are aimed to be avoided, they possess a high potential for effective professional learning (Bauer 2008). Reflection plays an important role in this respect: Errors are described as situations that provide opportunities to look back and think about the error's cause and consequences. Researchers have highlighted the importance of thorough, reflective error analysis as a means to avoid re-occurrence of an error (Tjosvold et al. 2004). Yet a more relevant question here is to what extent lessons learned from an error can be useful for avoiding similar errors through learning from those errors. One possible assumption is that a deep reflective analysis of an error leads to a fundamental understanding of their cause and source. Such a fundamental understanding about how an error occurred can be transferred to other error-critical situations in a workplace more effectively than measures based on an unreflective response to an error.

However, the nature of reflective analysis is assumed to be influenced by an individual's attitudes. Positive attitudes towards errors may encourage individuals to be more experimental and innovative (Rybowiak et al. 1999). Thus, attitudes towards errors are crucial for an individual's decision to accomplish reflective activities.

The concept of error orientation (Rybowiak et al. 1999) is of particular interest for the assessment of attitudes towards errors. The error orientation construct comprises eight facets. As these do not represent a self-contained theoretical construct (Bauer 2008), we undertook a selection of the facets suited to the heuristic goals of our study. The facets investigated here are: i) error competence, ii) learning from errors, iii) error strain, and iv) error risk taking. These facets are now discussed in turn, as well as the respective hypotheses concerning their influence on reflection.

(1) *Error competence* refers to individuals' persuasion that they have active knowledge and the capability to cope immediately with errors, involving a reduction in the adverse consequences of errors. Rybowiak et al. (1999) found positive correlations between error competence and action orientation after failure. Therefore, we expect that error competence has a positive impact on reflection at work.
(2) The basic difference between error competence and *learning from errors* lies in the time-frame of the two constructs: Error competence refers to a short-term perspective of coping with errors immediately, whereas learning from errors addresses long-term learning effects, such as well-directed improvements of

work processes (Rybowiak et al. 1999). Such a long-term perspective on learning focuses on the estimation that error-related learning experiences are episodes that may be beneficial for improving skills, knowledge and work practices (Bauer 2008). This attitude was found to be positively related to action orientation after failure (Rybowiak et al. 1999). Thus, we expect that learning from errors exerts a positive impact on reflection at work, and vice versa.

(3) *Error strain* is characterised by a generalised fear of committing an error and by negative emotional reactions (Rybowiak et al. 1999). Scholars agree that errors are associated with negative emotions, such as anger, shame, guilt and fear (Cannon and Edmondson 2001; Keith and Frese 2005; Zhao and Olivera 2006). However, the impact of such negative emotions on cognition and learning activities is conceptually ambiguous—both fostering and inhibiting effects have been found (Bauer 2008; Cannon and Edmondson 2005). Negative emotions related to errors can create stress and reluctance to change. Consequently, these emotions can cause individuals to avoid action-oriented behaviour and interfere with the accomplishment of cognitive processes, such as reflection (Edmondson 1999; Keith and Frese 2005). For example, Rybowiak et al. (1999) reported negative correlations of error strain to action orientation and initiative after an error. As there is a strong basis for assuming that error-related negative emotions inhibit cognition and productive learning, we hypothesise that error strain exerts a negative impact on reflection at work.

(4) *Error risk taking* is an attitude that implies general flexibility and openness towards errors. For instance, it might indicate whether individuals are willing to adjust to new conditions at work and to take responsibility despite the potential for negative consequences. There are positive relations between this attitude and readiness for change and initiative (Rybowiak et al. 1999), whereas the individual's interpretation of error as a threat, and, therefore, the tendency to cover up errors, can have inhibiting effects on the engagement in reflective activities (Bauer 2008). Thus, we hypothesise that error risk taking is positively related to reflection at work.

Psychological Safety as Mediator Between Attitude Towards Errors and Reflection

Evaluative norms specific to the particular socio-cultural environment determine whether an action is regarded as an error. This also applies to how an error is treated. The way in which colleagues and supervisors deal with errors does not only depend upon how they perceive errors, because they also take into account what is regarded as being common practice in their respective work environments. Hence, it can be assumed that a local, socially constructed and shared understanding exists of how to handle errors (Bauer 2008). This viewpoint is expressed in the concept of "psychological safety", which is defined here as an individual's perception of the work team being a safe environment for interpersonal risk taking—for example, openly admitting an error and seeking advice from team mates—without having to fear negative consequences (Baer and Frese 2003; Edmondson 1999). A safe team climate, characterised by interpersonal trust, mutual respect and supportive cooperation, is expected to increase the probability that team members engage in

collaborative learning activities that also involve reflective processes on the collective and individual level (Edmondson 1999; Tjosvold et al. 2004). Those reflective activities involve discussions about the conditions that led to an error and how to improve suboptimal work processes (Nyhan 2006). Accordingly, a supportive team leader who manages to create such a safe team climate can contribute to reducing errors by stimulating those reflective activities (Cannon and Edmondson 2001; Edmondson 1999; Tjosvold et al. 2004).

Regarding the mediation model to be investigated here, it is necessary to substantiate (i) how the investigated attitudes towards errors influence the individual's perception of psychological safety and (ii) how this perception, in turn, is associated with reflection at work.

(i) "Team members may be unwilling to draw attention to errors that could help the team make subsequent changes because they are concerned about being seen as incompetent" (Edmondson 1999, p. 355). Drawing upon this observation, we assume that employees' attitudes towards errors influence the reactions they expect from their work environment and—accordingly—the perceived psychological safety of the work environment. For instance, employees' trust in their own capabilities to deal with errors is expected to influence positively their perception of psychological safety. This is because error-competent employees themselves may be better able to support colleagues when errors occur and, thus, contribute to a safe team climate (Tjosvold et al. 2004).

(ii) In terms of how psychological safety affects reflection at work, we emphasise that a safe team climate stimulates collaboration and interaction among individuals. Therefore, it is proposed that psychological safety shapes how team members reflect on their performance, discover cause and effect relationships and address critical issues. Through identifying weaknesses and strengths in their own efforts they gain insight into their own behaviour (Nyhan 2006; Tjosvold et al. 2004). Each employee becomes familiar with different perspectives and interpretations that in turn may stimulate reflective processes on the individual level (van Woerkom 2003).

Method

Aims and Hypotheses

The primary aim of the study was to analyse the effects of attitude towards errors on reflection at work (Aim A). Furthermore, we examined the extent to which the working climate within the team (i.e. psychological safety-colleagues) as well as with regard to supervisors (i.e. psychological safety-supervisors) has a mediating effect on this relationship (Aim B). Based on theoretical considerations, we stated the following hypotheses:

Aim (A): Impact of error orientation on reflection

Hypothesis (A1): Error competence has a positive effect on reflection.
Hypothesis (A2): Learning from errors has a positive effect on reflection.

Hypothesis (A3): Error strain has a negative effect on reflection.
Hypothesis (A4): Error risk taking has a positive effect on reflection.

Aim (B): Mediating effect of working climate on the relationship between error orientation and reflection

Hypothesis (B1): The hypothesised effects of error orientation on reflection at work (A1–A4) are mediated by psychological safety-colleagues.
Hypothesis (B2): The hypothesised effects of error orientation on reflection at work (A1–A4) are mediated by psychological safety-supervisor.

Participants

The participants in this study were 84 client advisors (50% female, 45% male, 5% not reported) in the retail banking departments of a German bank. The professional experience varied from one to 43 years (M=15.8, SD=12.7); age ranged from 18 to 60 years (M=36.5, SD=13.0). The participants worked in different branch offices of the bank and all specialised in retail banking. The completion of the questionnaires was the first topic on the agenda of a general staff meeting, at which 87% of the client advisors working in the investigated bank were present.

Instruments

All scales applied in the study (error orientation, reflection, and psychological safety) used a six-point Likert scale ranging from *1 = totally agree* to *6 = totally disagree.*

Error orientation Attitudes towards errors at work were assessed by applying the German version of the error orientation questionnaire (EOQ; Rybowiak et al. 1999). Four out of the eight sub-scales were used: Error competence (four items, α=.80, M=2.06, SD=0.58; item example: *When I have made a mistake, I know immediately how to correct it*; factor loadings ranged from .67 to .97), learning from errors (four items, α=.86, M=2.36, SD=0.78; item example: *Mistakes assist me to improve my work*; factor loadings ranged from .80 to .88), error strain (five items, α=.63, M=4.17, SD=0.74; item example: *I am often afraid of making mistakes*; factor loadings ranged from .69 to .82), and error risk taking (four items, α=.77, M=2.77, SD=0.83; item example: *If one wants to achieve success at work, one has to risk making mistakes*; factor loadings ranged from .79 to .83).

Reflection We applied a Kauffeld et al. (2007) instrument for self-assessment of reflection at work. The questionnaire scale refers to the evaluation of own work processes and behaviour. It consists of four items, α=.84, M=2.33, SD=0.63. A sample item is: *After a project is finished, I reflect upon how problems and difficulties could be solved in a better way next time.* Factor loadings ranged from .79 to .85.

Psychological safety To measure the perceived working climate (i.e. psychological safety), we adapted items of established instruments (Edmondson 1999; Tjosvold et al. 2004; van Dyck et al. 2005). To be used in a German workplace, some items had to be translated from English. In a first step, the paper's first and second author independently translated the items. Next, all authors discussed the individual solutions and agreed on a most appropriate version. The final solution was translated back to English by a native English speaker. Deviances between translated and original items were discussed with the translator. On this basis, we decided on the final wording. Two four-item scales were built to assess psychological safety with regard to (1) colleagues (sample item: *In our team, problems and critical issues can be addressed anytime*) and (2) supervisors (sample item: *I can talk openly with my supervisor about errors I have made*).

We tested the scales with a sample of 49 employees working for a financial services company. The test yielded good reliability indices for both scales (psychological safety-colleagues: α=.72; psychological safety-supervisors: α=.81). In the present study, we calculated the following indices: psychological safety-colleagues: α=.78, M=2.44, SD=0.70; psychological safety-supervisors: α=.73, M=2.41, SD=0.64. Moreover, we conducted factor analyses: Factor loadings for psychological safety-colleagues ranged from .65 to .85; for psychological safety-supervisors from .66 to .83. The translation and adaptation of the instrument for assessing psychological safety in the study thus proved to be of sufficient quality.

Procedure

The bank's supervisors and the personnel board advised employees about the questionnaire in spring 2007. At the time the survey began, the investigators held a 10-minute introductory presentation during which they explained the aims of the study to the participants. Further, they were advised that the anonymity and confidentiality of the data was assured. In summer 2007, data collection was conducted during a general staff meeting in the bank. Completing the questionnaires took around 20 min. To ensure anonymity, the researchers collected the questionnaires directly after the participants completed them.

Analysis

The effects of error orientation on reflection at work were assessed by calculating correlation and multivariate regression analyses. The mediating role of psychological safety was analysed by calculating bivariate regression analyses and Sobel Tests (MacKinnon et al. 2002).

Results

Table 1 shows the results of correlation analyses including all applied scales. Significant interrelations were found between reflection and three facets of error

Table 1 Correlation analysis of all applied variables

	Variable	1	2	3	4	5	6	7
1	Reflection	–						
2	Error competence	.55**	–					
3	Learning from errors	.32**	.41**	–				
4	Error risk taking	−.00	.16	.50**	–			
5	Error strain	−.29**	−.28**	−.02	−.03	–		
6	Psychological safety–colleagues	.58**	.50**	.52**	.18	−.17	–	
7	Psychological safety–supervisors	.42**	.40**	.30**	.19	−.13	.44**	–

** = $p<.01$ (two-tailed)

orientation: Significant positive correlations were found between reflection and error competence ($r=.55$; $p<.01$), as well as learning from errors ($r=.32$; $p<.01$). A significant negative correlation was found between reflection and error strain ($r=-.29$; $p<.01$). Furthermore, we found interrelations between the sub-scales of error orientation: Learning from errors positively correlated with error competence ($r=.41$; $p<.01$) and error risk taking ($r=.50$; $p<.01$). Significant negative correlations were found between error strain and error competence ($r=-.28$; $p<.01$). In their magnitude and tendency, the calculated interrelations between the error-orientation sub-scales are similar to those reported by Rybowiak et al. (1999).

Regarding psychological safety-colleagues, significant positive correlations were found with reflection ($r=.58$; $p<.01$), error competence ($r=.50$; $p<.01$), and learning from errors ($r=.52$; $p<.01$). Significant positive interrelations were identified between psychological safety-supervisors and reflection ($r=.42$; $p<.01$), error competence ($r=.40$; $p<.01$), and learning from errors ($r=.30$; $p<.01$).

Aim (A): Impact of Error Orientation on Reflection

To assess the impact of error orientation on reflection, we conducted a multivariate regression analysis. All four sub-scales of error orientation were simultaneously included as predictors. We took measures for the prevention and control of multi-collinearity, as the correlations between error orientation sub-scales were substantial (Table 1). First, the analyses were conducted with centralised predictors (Cohen et al. 2003). Second, variance inflation factors (VIF) were calculated for all predictors. VIF values above 10 (VIF>10) are indicators for multi-collinearity of the predictors in the regression model (Hocking 2003).

As shown in Table 2, the regression analysis identified error competence and learning from errors as the strongest predictors of reflection. These two facets account for 34 per cent of variance. As all calculated variance inflation factors were lower than 10 (VIF=1.10 up to 1.60), there is no reason to believe that the results were affected by multi-collinearity.

In light of the reported results, we can confirm hypotheses A1 and A2, but we have to reject hypotheses A3 and A4.

Table 2 Multivariate regression analysis with error orientation as predictor for reflection

Criterion: Reflection Predictor	B	SE B	β	VIF
Error competence	.48	.11	.44**	1.34
Learning from errors	.19	.09	.23*	1.60
Error risk taking	−.15	.08	−.19	1.35
Error strain	−.15	.08	−.17	1.10

R^2_{adj}=34. *B* = regression coefficient; *SE B* = standard error of regression coefficient; β = standardised regression coefficient; *p<.05, **p<.01; VIF = variance inflation factors

Aim (B): Mediating Effect of Psychological Safety on the Relation Between Error Orientation and Reflection

With the aim of assessing whether psychological safety functions as a mediator, a three-step analysis was conducted. First, the predictive role of attitudes towards errors on psychological safety-colleagues and psychological safety-supervisors was tested using bivariate regression analyses (Table 3, "bivariate regression 1"). Second, bivariate regression analyses with psychological safety (colleagues/supervisors) were calculated as a predictor for reflection at work (Table 3, "bivariate regression 2"). It is necessary to calculate these two regression analyses to confirm significant effects, which are prerequisites for a mediation model. Thirdly, to test directly for mediation, we calculated Sobel Tests (Baron and Kenny 1986; MacKinnon et al. 2002) to examine the significance of mediator effects (Table 3, "Sobel test").

The results identified that both psychological safety-colleagues and psychological safety-supervisors mediate the influence that error competence and learning from errors have on reflection at work (Table 3). Hence, we can confirm hypotheses B1

Table 3 Regression analysis for assessing the mediating role of psychological safety

Criterion (Y): Reflection		Bivariate regression 1				Bivariate regression 2				Sobel test
Predictor (X)	Mediator (Z)	a) X→Z				b) Z→Y				
		B	*SE*	β	$R^2_{adj.}$	*B*	*SE*	β	$R^2_{adj.}$	*z*
CPT	PS–colleagues	.55	.11	.50**	.25	.57	.09	.58*	.33	3.92**
LRN		.43	.08	.52**	.27					4.10**
RSK		.14	.09	.18	.03					1.51
STR		−.15	.09	−.17	.03					−1.61
CPT	PS–supervisors	.49	.12	.40**	.16	.38	.09	.42**	.17	2.94**
LRN		.27	.10	.30**	.09					2.27**
RSK		.16	.09	.19	.04					1.64
STR		−.12	.10	−.13	.02					−1.15

$R^2_{adj} = R^2$ adjusted; *B* = regression coefficient; *SE* (*B*) = standard error of regression coefficient; β = Beta-value; *p<.05, **p<.01; CPT = error competence, LRN = learning from errors, RSK = error risk taking, STR = error strain, PS = psychological safety, z = z-value attained from the Sobel test

and B2 for these two error-orientation sub scales. Concerning error strain and error risk taking, we have to reject hypotheses B1 and B2. Figure 1 shows the identified mediating effect.

Prospects of Learning Through Errors

Researching reflection at work needs to account for both individual and contextual factors, such as attitudes towards errors and perceived psychological safety. Among the attitudes towards errors we investigated, learning from errors and error competence were the strongest predictors for reflective working behaviour. The predictive quality of error competence refers to an individual's estimation of whether there are worthwhile benefits from engaging in reflection on errors. Employees who are not persuaded that they have the knowledge and capabilities to cope with errors immediately might see no real benefit in reflection—they assume that they are unable to fix the error anyway, regardless of how deeply they have understood it. Thus, to make effective use of failure, organisations should support employees in building up a strong attitude towards their abilities to deal with errors successfully (Cannon and Edmondson 2005).

The role of learning from errors for predicting employees' reflection is also plausible in that employees tend to reflect upon errors more strongly when they expect it will yield helpful and relevant results for their future work (Harteis et al. 2007). Consistent with that proposition, recent research indicates that the estimation of an error as a chance for learning positively predicts individuals' engagement in social learning activities, such as reflection (Bauer 2008). Hence, reflective activity—which is fostered by the persuasion that an error is a valuable opportunity to learn—leads to a better understanding of the error's probable cause and the development of strategies to avoid such errors in the future (Bauer and Mulder 2007). Thus, the individual employee is able to have a feeling of being capable to contribute valuably to a cooperative error-related learning process. This, in turn, increases the possibility that the employee will participate in that process (Cannon and Edmondson 2001; Nyhan 2006; van Dyck et al. 2005).

Error risk taking and error strain did not contribute significantly to an increase in explained variance in the regression model. This finding is in line with Bauer (2008) who reported that, in contrast to theory-based expectations, error strain did not significantly predict engagement in social learning activities, such as cause analysis

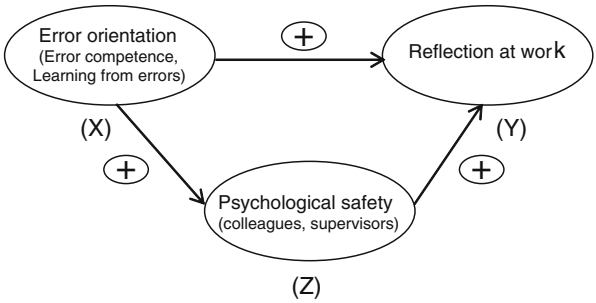

Fig. 1 Model for the identified mediating role of psychological safety

and development of new strategies. However, our results did identify a negative correlation between error strain and reflection at work. Willingness to learn from failure through the accomplishment of reflective activities decreases the more individuals perceive errors as unfavourable and react with negative emotions. Further, the identified negative interrelation between error strain and error competence indicates that the more individuals fear the occurrence of errors the less they trust in their capability and knowledge to deal with them. The perceived psychological safety within the team and with regard to supervisors could play an important role in this context. Workmates and supervisors can contribute to reduce the fear of committing errors through supportive behaviour and cooperative communication (Tjosvold et al. 2004). Thus, learning processes are facilitated that prevent future error occurrences and error-related stress situations (Edmondson 1999).

Psychological Safety as Mediator

The results confirm the mediating effect of psychological safety on the relationship between attitudes towards errors (error competence and learning from errors) and reflective working behaviour. Both constructs, psychological safety-colleagues and psychological safety-supervisors, are of significant relevance. The individual's belief in being able to cope successfully with error-related problems and challenges at work influences their perception of a climate in which the team provides support. Thereby, for example, they are more ready to put forward new ideas for work improvement (Tjosvold et al. 2004). Edmondson (1999) also found strong support for an association between perceived psychological safety and learning behaviour within a team.

The organisational conditions in the workplaces of the client advisors who participated in our study can help to explain the results. The client advisors basically work together in small teams located in the bank's branch offices. Hence, their daily work is carried out within a small group of team members. This organisational structure obviously supports informal learning processes when errors occur. Further, it can be assumed that each branch office provides space for the accomplishment of work actions that support reflective activities within a cooperative framework.

Concerning the mediating effect of psychological safety-supervisors, our results stress the important role of supervisors in error-related learning processes. "Good" supervisors support both short-term, error-induced corrections of work processes and long-term work improvements resulting from errors. The results indicate that reflective working behaviour as part of error-related learning processes in general is fostered both through a safe team climate and through appropriate leadership behaviour. Cannon and Edmondson (2005) stressed that leaders are required to have strong interpersonal skills for handling error situations. Public embarrassment through finger-pointing or name-calling discourages employees from identifying and analysing failures. Further, it inhibits constructive discussions through which individual and collective learning occurs.

In summary, our results strongly indicate that a working climate based on mutual trust, helpful co-operation and constructive communication supports the beneficial effects on reflection that are derived from employees' positive attitudes towards errors.

Learning Through Errors

Instead of viewing changes at work and errors arising through work as being wholly unwelcome, it is proposed here that these events can potentially provide the basis for rich and ongoing learning as part of working life. Such events require responses from both workers and workplaces. The responses from workers constitutes, in part, learning arising from and through these events. Necessarily, engaging with change generates new knowledge, adapting what is known and refining further what individuals do in and through their work. Equally, errors provide opportunities for engaging in learning from these deviations of what was anticipated or expected. Yet, the richness and the depth of this learning will likely be premised upon the kinds of capacities and dispositions possessed by the learners, on the one hand, and how the workplace affords support for and reacts to these changes and the making of errors. What was found in this study is that individuals are most likely to be productive learners when confronting changes and also when dealing with errors when they are prepared through active reflection on errors, thus reducing error strain at work. Yet, it was also found that workplaces need to provide a safe working climate, both concerning the work relations with peers and the leadership of supervisors. In all, given that change in the requirements for work will be ongoing and likely to increase in both frequency and scope that learning through change will become as inevitable as these changes themselves. Hence, it is important that effective means for learning through and from changes are enacted in workplaces. Also, although usually undesirable, errors will occur, and with the predicted frequency and scope of change likely more often in the future. Hence, these incidents need to be maximised as effective learning experiences to reduce the prospect of them reoccurring and to exploit their worth as learning moments.

Acknowledgements This work was supported by the Deutsche Forschungsgemeinschaft (German Research Foundation) through a grant (GR 1384/11-2) awarded to Hans Gruber and Helmut Heid. We thank the anonymous reviewers for helpful comments on this article.

References

Anderson, L., & Thorpe, R. (2004). New perspectives on action learning: developing criticality. *Journal of European Industrial Training, 28*, 657–668.

Baer, M., & Frese, M. (2003). Innovation is not enough: climates for initiative, psychological safety, process innovation and firm performance. *Journal of Organizational Behavior, 24*, 45–68.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychology research: conceptual, strategic and statistical consideration. *Journal of Personality and Social Psychology, 51*, 1173–1182.

Bauer, J. (2008). *Learning from errors at work: Studies on nurses' engagement in error-related learning activities*. Doctoral dissertation, University of Regensburg, Germany. http://www.opus-bayern.de/uni-regensburg/volltexte/2008/990 (Accessed April 21, 2010).

Bauer, J., & Mulder, R. H. (2007). Modelling learning from errors in daily work. *Learning in Health and Social Care, 6*, 121–133.

Berg, A., & Hallberg, I. R. (2001). Effects of systematic clinical supervision on psychiatric nurses' sense of coherence, creativity, work-related strain, job satisfaction and view of the effects from clinical supervision: a pre-post test design. *Journal of Psychiatric and Mental Health Nursing, 6*, 371–381.

Billett, S. (2001). Learning through work: workplace affordances and individual engagement. *Journal of Workplace Learning, 13*, 209–214.

Boud, D. J., & Walker, D. (1991). *Experience and learning: Reflection at work*. Geelong: Deakin University Press.

Boud, D. J., Keogh, R., & Walker, D. (1989). Promoting reflection in learning: a model. In D. J. Boud, R. Keogh, & D. Walker (Eds.), *Reflection: Turning experience into learning* (pp. 18–40). London: Kogan Page.

Boud, D. J., Cressey, P., & Docherty, P. (Eds.). (2006). *Productive reflection at work*. London: Routledge.

Cannon, M. D., & Edmondson, A. C. (2001). Confronting failure: antecedents and consequences of shared beliefs about failure in organizational work groups. *Journal of Organizational Behavior, 22*, 161–177.

Cannon, M. D., & Edmondson, A. C. (2005). Failing to learn and learning to fail (intelligently): how great organizations put failure to work to innovate and improve. *Long Range Planning: International Journal of Strategic Management, 38*, 299–319.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression / correlation analysis for the behavioural sciences*. Hillsdale: Erlbaum.

Edmondson, A. C. (1999). Psychological safety and learning behavior in work teams. *Administrative Science Quarterly, 44*, 350–383.

Ellström, P.-E. (2006). The meaning and role of reflection in informal learning at work. In D. J. Boud, P. Cressey, & P. Docherty (Eds.), *Productive reflection at work* (pp. 43–53). London: Routledge.

Gartmeier, M., Kipfmueller, S., Gruber, H., & Heid, H. (2008). Reflection and professional competence. A study at dynamic workplaces in the nursing sector. In S. Billett, C. Harteis, & A. Eteläpelto (Eds.), *Emerging perspectives of workplace learning* (pp. 131–147). Rotterdam: Sense.

Harteis, C., Bauer, J., & Haltia, P. (2007). Learning from errors in the workplace—insights from two studies in Germany and Finland. In H. Gruber & T. Palonen (Eds.), *Learning in the workplace—new developments* (pp. 119–138). Turku: Finnish Educational Research Association.

Hocking, R. R. (2003). *Methods and applications of linear models*. New York: Wiley.

Høyrup, S. (2004). Reflection as a core process in organizational learning. *Journal of Workplace Learning, 16*, 442–454.

Høyrup, S., & Elkjaer, B. (2006). Reflection. Taking it beyond the individual. In D. J. Boud, P. Cressey, & P. Docherty (Eds.), *Productive reflection at work* (pp. 29–42). London: Routledge.

Kauffeld, S., Grote, S., & Henschel, A. (2007). Das Kompetenz-Reflexions-Inventar (KRI) [The competence reflection inventory]. In L. von Rosenstiel & J. Erpenbeck (Eds.), *Handbuch Kompetenzmessung* (pp. 337–347). Stuttgart: Schäffer-Poeschel.

Keith, N., & Frese, M. (2005). Self-regulation in error management training: Emotion control and metacognition as mediators of performance effects. *Journal of Applied Psychology, 90*, 677–691.

Kim, D., & Lee, S. (2002). Designing collaborative reflection supporting tools in e-project based learning environments. *Journal of Interactive Learning Research, 13*, 375–392.

MacKinnon, D. P., Lockwood, C. M., Hoffman, J. M., West, S. G., & Sheets, V. (2002). A comparison of methods to test mediation and other intervening variable effects. *Psychological Methods, 7*, 83–104.

Marienau, C. (1999). Self-assessment at work: outcomes of adult learners' reflections on practice. *Adult Education Quarterly, 49*, 135–146.

Moon, J. A. (1999). *Reflection in learning and professional development. Theory and practice*. London: Routledge.

Nyhan, B. (2006). Collective reflection for excellence in work organizations: An ethical 'community of practice' perspective on reflection. In D. J. Boud, P. Cressey, & P. Docherty (Eds.), *Productive reflection at work* (pp. 133–145). London: Routledge.

Raehalme, O. (1999). The bank office as a learning environment. In P. Ruohotie, J. Honka, & A. Suvanto (Eds.), *The developmental challenges in the cooperation of education and training and working life* (pp. 71–80). Tampere: Edita.

Reason, J. (1990). *Human error*. Cambridge: Cambridge University Press.

Rybowiak, V., Garst, H., Frese, M., & Batinic, B. (1999). Error Orientation Questionnaire (EOQ): reliability, validity and different language equivalence. *Journal of Organizational Behavior, 20*, 527–547.

Strasser, J., & Gruber, H. (2005). Reflection and the development of psychological counsellors' professional knowledge. In H. Gruber, C. Harteis, R. H. Mulder, & M. Rehrl (Eds.), *Bridging individual, organisational, and cultural perspectives on professional learning* (pp. 221–226). Regensburg: Roderer.

Tjosvold, D., Yu, Z., & Hui, C. (2004). Team learning from mistakes: the contribution of cooperative goals and problem-solving. *Journal of Management Studies, 41*, 1223–1245.

Van Dyck, C., Frese, M., Baer, M., & Sonnentag, S. (2005). Organizational error management culture and its impact on performance: a two-study replication. *Journal of Applied Psychology, 90*, 1228–1240.

Van Woerkom, M. (2003). *Critical reflection at work. Bridging individual and organisational learning*. Enschede: PrintPartners.

Zhao, B., & Olivera, F. (2006). Error reporting in organizations. *Academy of Management Review, 31*, 1012–1030.

Stefanie Hetzner is a PhD candidate currently working in a research project called "Competence development in the Work Process—the Role of Workplace Changes and Reflection for Workplace Learning" at the Institute of Education, University of Regensburg (Germany). In her dissertation, she studies individual and contextual factors that support reflection at work and professional learning.

Martin Gartmeier PhD is currently working in a research project called "ProfKom—Professionalization of future physicians and teachers on the level of their communicative competence" at the School of Education, Technical University of Munich (Germany). In his dissertation, he studied negative knowledge at the workplace.

Helmut Heid is professor emeritus in educational science at the Institute of Educational Science, University of Regensburg (Germany). His main research interests are lifelong learning and basic principles of educational research.

Hans Gruber is full professor in educational science at the Institute of Educational Science, University of Regensburg (Germany). His main research interests are professional learning, expertise, and learning from experience at work.