Informal learning in the context of industrial work –

Conceptualization, operationalization, antecedents, and

learning outcomes

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Summary

Informal workplace learning is the predominant form of work-related learning. Especially among semi-skilled and unskilled industrial employees in small and medium-sized enterprises (SMEs), learning barriers exist with regard to formal education and training. Among the reasons for these barriers are limited human resource development budgets of SMEs, reservations of employees as well as the effects of technological change including a decreasing half-life of knowledge. In the aforementioned target group, informal learning can provide an answer to the challenges of continuing education.

This research paper therefore examines the role that informal learning plays in the qualification of industrial employees in SMEs. Starting from the conceptual history of work-related informal learning, the development of various definitions of the construct is traced and definitional commonalities as well as differences are elaborated. In addition, relevant conceptual models of informal learning in the workplace are presented. In order to subsequently distinguish the learning form of informal learning from other learning forms, the term "learning form" is first defined and seven dimensions for characterizing learning forms are developed. By means of these dimensions, the following nine forms of learning are distinguished from informal learning and explained using examples from the work context: formal learning, incidential learning, self-regulated learning, deliberate practice, experiential learning, transformational learning, situated learning, work-based learning.

On this basis, the three research questions of this thesis are answered based on three sub-studies conducted, always regarding the context of industrial employees in SMEs:

1. How can informal learning in the workplace be conceptualized and operationalized?
2. What constructs precede informal learning as antecedents and what constructs are outcomes of informal learning?
3. What are the interactions between working conditions and informal workplace learning over time?

In sub-study 1, the octagon model of informal learning in the workplace is developed on the basis of qualitative interview results and theoretical considerations. In addition, a 24-item measurement instrument for operationalizing informal learning is presented, which is developed and validated using survey data from a total of 895 industrial employees in SMEs. In addition, an 8-item short version of the scale, which is yet to be validated, is presented.

In sub-study 2, the APO framework model of the antecedents, processes and learning outcomes of informal learning in the workplace is developed, which is based on an input-process-output perspective. The assumptions resulting from the model are empirically tested

simultaneously using structural equation modeling based on a sample of 702 industrial employees in SMEs - seven of the eight hypotheses can be confirmed. As the results show, both personal and organizational antecedents are related to informal learning at the workplace.

Substudy 3 examines two opposing assumptions on the basis of a sample of 129 industrial employees in SMEs at two measurement points with a time interval of 1.5 years: on the one hand, the "active learning hypothesis" originating from the job demand control model, and on the other hand, the "active adaptation hypothesis" originating from the job crafting theory. Contrary to the majority of studies published to date, most of which are cross-sectional, informal learning has a causal influence on working conditions (namely work requirements and decision-making scope) - and not vice versa. Thus, in the context of industrial employees in SMEs, the "active-adaptation hypothesis" receives evidence.

Finally, theoretical implications and research desiderata as well as practice recommendations resulting from these research findings are discussed.

Keywords

Informal learning in the workplace, semi-skilled and unskilled industrial workers, small and medium enterprises, forms of learning, definition and operationalization of informal learning, octagon model, antecedents of informal learning, outcomes of informal learning, working conditions, "active learning hypothesis," "active adaptation hypothesis"

Abstract

Informal workplace learning is the predominant form of work-related learning. Particularly among semi-skilled and unskilled blue-collar workers in small and medium-sized enterprises (SMEs) there are learning barriers to formal education and training. Reasons for these obstacles are limited personnel development budgets of SMEs, concerns of employees and the effects of technological change including a decreasing half-life of knowledge. In the mentioned target group, informal learning can serve as an answer to the challenges of continuous vocational education.

Therefore, this thesis investigates the role informal learning plays for the qualification of blue-collar workers in SMEs. Based on the terminological history of informal learning, the evolution of various construct definitions is reconstructed, and definitional similarities and differences are identified. Furthermore, relevant conceptual models of informal workplace learning are presented. In order to differentiate the learning form of informal learning from other learning forms, the concept "learning form" is defined and seven dimensions for characterizing learning forms are developed. Using these dimensions, the following nine learning forms are distinguished from informal learning and illustrated with examples from the work context: formal learning, incidental learning, self-regulated learning, deliberate practice, experiential learning, transformative learning, situated learning, work-based learning.

On this basis, three research questions of this thesis will be answered by means of three studies, all concerning the context of blue-collar workers in SMEs:

1. How can informal workplace learning be conceptualized and operationalized?
2. Which constructs precede informal workplace learning as antecedents and which constructs are results of informal workplace learning?
3. Which interactions exist between working conditions and informal workplace learning over time?

In Study 1, the octagon model of informal workplace learning is developed based on qualitative interview results and theoretical considerations. In addition, a 24-item measure for the operationalization of informal workplace learning is presented, which is developed and validated using survey data from a sample of 895 blue-collar workers in SMEs. In addition, an 8-item short version of the scale is introduced, which still has to be validated.

In study 2, the APO framework of antecedents, processes and learning outcomes of informal workplace learning is developed, which is based on an input-process-output perspective. The assumptions resulting from the model are simultaneously tested empirically with structural equation modeling, using a sample of 702 blue-collar workers in SMEs. Seven of the

eight hypotheses can be confirmed. The results show that both personal and organizational antecedents are related to informal workplace learning.

Study 3 examines two opposing assumptions with a sample of 129 blue-collar workers in SMEs, using two measurement points with a time interval of 1.5 years: the "active learning hypothesis" derived from the job demand-control model and the "active shaper hypothesis" derived from job crafting theory. In contrast to most of the previously published, but predominantly cross-sectional studies, it can be shown that informal workplace learning has a causal influence on working conditions (namely work demands and decision latitude) - and not vice versa. Thus, in the context of blue-collar workers in SMEs, the "active shaper hypothesis" receives evidence.

Finally, theoretical implications and research desiderata as well as practical recommendations resulting from these findings are discussed.

Keywords

informal workplace learning, semi-skilled and unskilled blue-collar workers, small and medium-sized enterprises, learning forms, definition and operationalization of informal workplace learning, octagon model, antecedents of informal workplace learning, outcomes of informal workplace learning, working conditions, "active learning hypothesis", "active shaper hypothesis".

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So one decision is that man has to learn something.
But, thank God, you can learn throughout your life.
(Deutsche Post, 2001, special stamp "Lifelong Learning"[1])

1. Introduction

1.1 On the importance of small and medium-sized enterprises in industry

Small and medium-sized enterprises (SMEs) are the engine of the economy. This is true not only for Germany, but also for Europe as a whole and for large parts of the industrialized world. SMEs represent more than 95% of all enterprises in the countries of the *Organization for Economic Cooperation and Development and* employ more than half of all employees in the private sector (Lukács, 2005). Within the European Union (EU), SMEs account for as much as 99.8% of all enterprises in the non-fiscal economy (i.e., industry, construction, trade, and services) (European Commission , 2017). In this context, the EU defines SMEs as enterprises with fewer than 250 employees, an annual turnover of up to €50 million, and an annual balance sheet total of up to €43 million (European Commission, 2003). In 2015, SMEs in the EU employed 66.8% of all employees and accounted for 57.4% of the total turnover of all enterprises (European Commission, 2017). These figures underline the high economic and social importance of SMEs, which also contribute greatly to the overall economic innovation capacity (Perkins, 2018): although only 10% of SMEs continuously spend money on research and development, 35% of SMEs regularly present product or process innovations (Rammer et al. , 2018).

A large part of the economic output of SMEs is generated in the manufacturing and processing sector (cf. European Commission, 2017). In addition to skilled workers with completed apprenticeships or vocational training, this sector also employs many semi-skilled and unskilled workers, who often perform so-called simple work (Abraham, 2010, p. 28; Ittermann, Abel & Dostal, 2011). Employees in the area of simple work - in 2007, it was 23% of employees in industry (Abel, Hirsch-Kreinsen & Ittermann, 2009) - are involved, for example, in machine operation, simple assembly of prefabricated components, order picking or material provision . Despite the increased digitization and introduction of "Industry 4.0" elements in the manufacturing sector, Abel and colleagues assume that simple labor is anything but a discontinued model, but in contrast to skilled labor even has a more stable perspective (Abel et al., 2009;

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[1] The first sentence of the quote comes from the work "Max und Moritz - Eine Bubengeschichte in sieben Streichen" by Wilhelm Busch, first published in 1865. The second sentence was added by Deutsche Post and printed on a special stamp together with a likeness of teacher Lämpel, a character from "Max und Moritz".

Abel, Hirsch-Kreinsen & Ittermann, 2014). It can be assumed that certain simple jobs will disappear due to the increasing automation of production. On the other hand, new jobs would be created in this area, as simple control and monitoring work previously performed by skilled workers could also be taken over by semi-skilled workers thanks to technical assistance systems (Abel et al., 2009). In addition, so-called automation gaps would be closed by simple work (Hirsch-Kreinsen, 2016). This concerns activities such as the constant replenishment of production material and the insertion of raw parts into machines - ergo such tasks that can be performed more efficiently by human workers than by costly plant and robot technology.

These developments in industrial work require employees - including semi-skilled and unskilled employees - to acquire further qualifications in order to meet the future work requirements in SMEs (Abel, Decius, Güth & Schaper, 2016; Decius & Schaper, 2017). The maxim of so-called lifelong learning has thus also arrived in industry (cf. e.g. e.g., Gössling & Sloane, 2015; Schmidt-Hertha, 2014, with a special focus on low-skilled employees; see Hof, 2009, or Schemmann, 2002, for an overview). Classically, qualification in the industrial work context is understood as formal training[2] , for example, advanced training and (re)training (see Abel & Wagner, 2017). However, there are three obstacles that make formal learning more difficult for the target group of industrial employees in SMEs.

1.2 Challenges in in-company training for small and medium-sized enterprises

The first obstacle relates to the human resource development capabilities of SMEs. Due to fewer resources, SMEs are less able to invest time and money in formal training for their employees than larger companies (Abel et al., 2016; Abel & Wagner, 2017; Coetzer, Kock & Wallo, 2017; Decius & Schaper, 2017). Often, in practice, skills training for commercial workers emphasizes cost above all else - rather than the investment in improved task performance by employees in the future (Mesaros, Vanselow & Weinkopf, 2009). As a result, employer-sponsored training occurs much less frequently in smaller companies than in larger firms (Bishop, 2017; Shah, 2017). Moreover, in SMEs, task areas with a long-term focus, such as HR development, are often overshadowed by the demands of day-to-day business (Virgillito, 2018) or do not have a specific budget. In the HR departments of smaller companies, generalists then take care of all HR matters (Decius & Schaper, 2020) - and are often busy with payroll, recruiting and personnel selection (Abel et al., 2016). Externally offered training measures are also rarely

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[2] Continuing education can be defined as "learning activities undertaken by individuals to further develop qualifications or competencies following basic vocational training phases" (Schaper, 2019, p. 510).

geared to the needs of SMEs (Lundkvist & Gustavsson, 2018); moreover, approaches and intervention measures developed for large companies can hardly be transferred to SMEs (Wong & Aspinwall, 2004). In general, SMEs lack cost-effective competence development concepts that can be implemented with little effort and even by employees without a human resource management background (Moll & Weidner, 2018). Galilee and Wende (2008) note: "Qualification measures for [employees] at lower hierarchical levels are generally limited to partial instruction on the job by personnel who are often not or insufficiently qualified for this. The personal strengths of these [employees] can thus neither be identified nor developed in a targeted manner" (p. 82).

The second barrier relates to individual learning barriers among semi-skilled and unskilled workers. In this context, workers considered to be low-skilled can be divided into three groups (Illeris, 2006):

1. Adult school dropouts who have not participated in or completed formal, qualifying vocational training.
2. People who have learned a once solid and recognized training profession, but which is no longer in demand due to changes in the labor market.
3. (Often young) adults who have not taken up permanent employment following their schooling, but have financed themselves with casual jobs and acquired considerable but unrecognized skills on their own (sometimes tortuous) paths.

In particular, those in the first group who left their schooling or training without a degree are often skeptical or even dismissive of formal, classroom-based continuing education formats due to their prior experiences (Bimrose, Mulvey & Brown, 2016; Decius, Schaper & Seifert, 2019). Lower-skilled workers are also more likely to express fears of continuing education and reservations about the benefits of continuing education compared to higher-skilled workers (Tippelt, Reich & Panyr, 2004). These could be reasons why individuals with lower educational qualifications are significantly less likely to participate in continuing education programs (Schönfeld & Behringer, 2017; Schröder, Schiel & Aust, 2004, p. 81). In addition, the share of persons with a migration background in simple industrial work is a comparatively high 20% (compared to 10% in industry as a whole; Ittermann et al., 2011), which is partly accompanied by language barriers among some employees. Reading and spelling difficulties also fostered reluctance to engage in formal training among this employment group (Virgillito, 2018). Abel and Wagner (2017) state:

It is striking that participation in training measures depends on the employee's position or training. Managers participate in 70% of training measures, while unskilled and semi-skilled workers only participate in around 30%. Skilled workers are in between at 54% (Bilger, Gnahs, Hartmann

& Kuper, 2012). In addition, there is a certain randomness in the selection of qualification measures. Since SMEs are often already struggling to identify needs, they are overburdened with the task of finding solutions that are a perfect fit - and this also applies to training close to the workplace. (S. 138)

The third obstacle is of a more general nature and relates to the requirements of the modern working world. Due to increasing digitalization, mechanization, and globalization, work processes are undergoing ever more rapid change, which also affects the competence requirements of employees (Harteis, 2018; Regan & Delaney, 2011). From a technological perspective, according to Cascio and Montealegre (2016), there are the following four trends, each of which entails production process changes: (1) Electronic control and instruction systems (real-time evaluation of industrial work), (2) Human-machine interaction and intelligent robotics, (3) Virtual team communication and decentralized work across different locations, (4) Wearable computing, such as data glasses, work clothes with sensor technology, or exoskeletons.

These partly disruptive changes in the world of work lead to an ever decreasing half-life of knowledge, so that knowledge acquired in trainings becomes obsolete and loses practical value faster than before (cf. Myskovszky von Myrow, Lemme, Stiller & Cernavin, 2015; Porath, 2010). Also contributing to this development are increasing customer demands, which cause SMEs to offer increasingly specific products (up to batch size 1), to deliver them without errors, and to react flexibly in terms of time to changes in orders (cf. Algedri & Frieling, 2015, p. 54). As a result, knowledge requirements become less plannable and "learning on the fly" becomes less efficient (Molzberger, 2008, p. 179). Instead, learning requirements arise unexpectedly from challenges that arise at work and require quick, situational and individual solutions to problems. Learning in SMEs, in particular, is characterized by the fact that it is required very suddenly, that workers must learn very quickly, and that they must directly apply what they have learned (Jeong, McLean & Park, 2018). Under the increasing external pressure from globalization processes and more demanding customer requirements, smaller companies in particular also face increasing difficulties in releasing employees to participate in (external) formal training, as it is difficult to compensate for the temporary loss of the workforce (Blings, 2008, p. 13). This increasing workload, also accompanied by difficulties in mustering the necessary level of energy and attention to participate in training and education, is a not insignificant obstacle to formal continuing education in today's workplace (Noe, Clarke & Klein, 2014).

1.3 Informal learning as a potential answer to the challenges of continuing education

So-called informal learning is hardly affected by these obstacles, as will be explained below. First, however, it is worth taking a look at what is meant by the term informal learning. According to Duden, the word "informal" has two meanings: on the one hand "without [formal] assignment", on the other hand "without formalities, not official" (Duden, n.d.[b]). In connection with learning and continuing education, the first meaning is particularly relevant: Informal learning is characterized by a low degree of planning and organization regarding the learning context, learning support, learning time, and learning goals (Kyndt & Baert, 2013)- there is no formal learning mandate. It makes sense that in informal learning, the situation or context in which the learning process takes place should be mentioned in each case, i.e., in this case, informal learning in the *workplace* (Overwien, 2002). Often, informal learning in the workplace is triggered by new or challenging work demands, mistakes made at work, or feedback from others (Hirschmann & Mulder, 2018, p. 41). As a result of the learning process, work process knowledge mostly emerges, which "enable[s] to cope with complex work and problem situations in everyday work" (Dehnbostel, 2008, p. 74). General advantages of informal learning cited include flexibility and adaptation to learning needs, direct transfer of learning into practice, and quick resolution of work-related problems (Dale & Bell, 1999, p. iv). For employees to improve their performance, the performance of their job appears to be the most important source of learning (Felstead et al. , 2005, p. 368).

Informal learning in the workplace is considered the predominant form of professional learning, especially in small and medium-sized enterprises (Bishop, 2020). Some sources speak of 60 to 90 percent that informal learning is said to occupy in total vocational learning (Cerasoli et al., 2018; Dehnbostel, 2015; Eraut, 2010; Eraut, 2011; Fromme-Ruthmann, 2013, p. 202; Marsick & Watkins, 1990; see Rohs, 2009, for a critical overview). Coffield (2000, p. 1) illustrates the dominant position of informal learning with significantly lower visibility in education compared to formal learning with the metaphor of an iceberg: the part of the iceberg that is visible above the water surface and makes up one third stands for formal learning; the two thirds below the water surface that are invisible at first glance stand for informal learning.

Particularly well-known in practice and used as a guideline is the "70-20-10 rule" dating back to Lombardo and Eichinger (1996), according to which 70 percent of actual learning takes place through dealing with professional challenges and "learning by doing," 20 percent through interactions with people in the professional environment, and only 10 percent through formal education and training. However, a qualitative study of the implementation of the 70-20-10 framework in the Australian public service did not find the positive effects on

learning transfer that had been hoped for (Johnson, Blackman & Buick, 2018). Clardy (2018) also criticizes advocates of this "rule" for relying on few studies that are cited more frequently. He links these research studies to sloppy study design, inconsistent conceptualization of informal learning, and fundamental methodological problems. Rohs (2009) also points to the difficulties of capturing informal learning in numbers and speaks of the "percentage problem" (p. 35). Nevertheless, neither Clardy nor Rohs doubt the fundamental importance of informal learning for continuing vocational education and training, but merely warn against rigidly fixing the learning share to a percentage figure.

Although the importance of informal learning is undisputed in research and practice, there is dissent about the definition and conceptualization of the construct (cf. e. g. e.g., Giese & Wittpoth, 2015; Werquin, 2016; see detailed description in chapter 2.2). The present work essentially builds on the construct definition of Cerasoli et al. (2018, p. 204). According to this definition, informal learning behaviors encompass those behaviors that occur outside of formally defined learning contexts and curricula and serve the acquisition of knowledge and skills. Such activities are predominantly self-directed by the learner, intentional (and thus conscious), and "field-based," i.e., they occur in the real (work) environment. Essentially, the behavioral components of informal learning are trying out and applying problem-solving strategies, interacting with other people (e.g., getting feedback on one's work performance), and reflecting on one's own work performance (Tannenbaum, Beard, McNall & Salas, 2010).

The first obstacle with regard to formal learning - the scarcity of resources in SMEs for organizing and conducting training courses - plays a subordinate role in informal learning. Informal learning is to a large extent controlled by the learner him/herself and therefore does not require time-consuming and cost-intensive planning, provision of course materials or involvement of external teaching staff. It is true that learning time is also required for informal learning behavior (e.g. for trying out one's own solution ideas or reflecting on the results of one's work) and the involvement of other people is necessary for feedback processes. However, these learning behaviors take place directly in the work process, have a direct benefit for the fulfillment of the work task and do not burden the SME's personnel development budget. Moreover, empirical studies in the SME context indicate that informal learning activities are positively related to innovation performance (e.g., Moen, Benum & Gjærum, 2018) and employee work engagement (e.g., Coetzer, Susomrith & Ampofo, 2019).

The second obstacle - the individual barriers to learning among industrial employees - is cushioned in the case of informal learning by the fact that it is free of school-based elements that can trigger further training fears. Informal learning among industrial employees mostly takes place without writing, for example through exchanging experiences with colleagues, trying out new solutions at work on their own and reflection processes. As a result, the barrier to

entry for employees who want to continue their education is significantly lower than it would be if they were enrolled in a course or training. Because of the high degree of self-direction in learning, for example with regard to the timing and content of learning, informal learning always ties in with the learner's level of knowledge and experience.

The third obstacle - the rapidly changing demands of the modern world of work - is countered in informal learning by the high flexibility of the learning process. Informal learning has the advantage over formal learning that the purpose of learning is not learning itself, but solving a concrete problem that arises while working on a task (Boud & Rooney, 2018; Jacobs & Park, 2009; Schaper & Sonntag, 2007, p. 618; Segers, Messmann & Dochy, 2018). This creates an authentic learning situation that facilitates the transfer of learning outcomes into the work process (Billett, 1995). Learning transfer, i.e., the application of what has been learned outside the learning situation or the transfer to novel contexts that differ from the learning situation, plays an important role in continuing education (Blume, Ford, Baldwin & Huang, 2010). Thus, especially in the evaluation of formal training, great emphasis has long been placed on successful transfer of learning-for example, *transfer* is included as a key element of the third stage, "behavior," in Kirkpatrick's classic evaluation typology (after stage 1, "reaction," and stage 2, "learning," and before stage 3, "outcomes"; Kirkpatrick & Kirkpatrick, 2006). Nevertheless, according to empirical evidence, there is only a slight correlation between learning success in trainings and sustainable transfer into the work process (cf. Creon & Schermuly, 2019), moreover with a further decreasing tendency over time after the training (e.g., Saks & Belcourt, 2006). Training research refers to this as the "transfer problem" and sees this circumstance as one of the main obstacles to in-company training (Blume et al., 2010; Grossman & Salas, 2011).

Important factors influencing the transfer of learning are the personal characteristics of the training participants, the training design, and the working environment (Baldwin & Ford, 1988). Another problem frequently encountered in practice is that formal training often has to be planned well in advance. At the time of planning, there is an urgent need for learning - then at the time of implementation, other challenges may be the focus of the employees. In informal learning, on the other hand, the interval between the occurrence of the learning trigger (e.g. a problem to be solved in the work process) and the learning action is short, since learning takes place as needed during work or close to work (e.g. during work breaks or a shift change). Through the often direct application of what is learned, for example the imitation of a handle of a colleague working on a similar machine (model learning), the transfer of learning takes place efficiently and effectively in a natural way.

Moreover, in informal learning, it can be assumed in principle that learners are highly self-motivated (Tannenbaum et al., 2010), which plays an important role in the learning context (Colquitt, LePine & Noe, 2000; Cerasoli, Nicklin & Ford, 2014). Studies of learning transfer

from formal training programs, on the other hand, often focus less on the learner themselves and more on managerial support (Govaerts & Dochy, 2014). However, Nijman and Gelissen (2011) were able to show in their study with service workers in the technology sector that the transfer climate does depend to a large extent on support from the manager - but the actual transfer outcome is then not significantly determined by the transfer climate, but by the transfer motivation of the learners. Transfer motivation, in turn, was not significantly predicted by manager support. In situations where the manager's influence is limited and the learner's own motivation is more important, informal learning has an advantage over formal learning.

Despite the high importance of informal learning, the potentially "dark side" of informal learning activities should also be pointed out at this point (see in more detail in chapter 4.5). This is learning that does not take place in the spirit of the organization (Cerasoli et al., 2018), e.g., the non-authorized sharing of information between employees. This can also be personally dangerous for workers, for example, when learning to circumvent a perceived inconvenience of a safety precaution in machine operation is learned through observation or (often well-intentioned) cues from colleagues. Ways to mitigate these risks will be addressed later in this research (see Chapter 4.5). At this point, it remains to be stated that the previously mentioned advantages generally outweigh possible disadvantages of informal learning, even though there may be industry-specific exceptions with particularly high safety requirements. The future of continuing education in industry thus belongs in particular to informal learning in the workplace.

1.4   Research questions

Based on the presented considerations, three questions arise for both research and practice, which will be addressed in this paper - always with regard to the specific framework conditions of informal learning of industrial employees in SMEs. The first question is:

How can informal learning in the workplace be conceptualized, i.e., presented as a concept that is as complete as possible, and operationalized, i.e., made measurable?

The answer to this question is especially relevant because, as already mentioned, there is disagreement in research about the definition and the demarcation from related constructs. For example, scholars call for a clear conceptualization of informal learning, including the components of this form of learning, in order to clearly distinguish it from related forms of learning (Bell, Tannenbaum, Ford, Noe & Kraiger, 2017, p. 317) . Noe et al. (2014) also encourage further research on the construct validity of informal learning in order to understand the

nomological network, i.e., the constructs related to informal learning, in more detail. Moreover, making informal learning measurable is not only important for conducting quantitative empirical research on informal learning, but also for corporate training practices: By surveying informal learning processes of employees, the development of learning-promoting framework conditions can be tailored to the learning needs in the company and the workforce can also be individually supported. Although a few measurement instruments based on self-assessment already exist for surveying informal learning (e.g. Noe, Tews & Marand, 2013) - however, these scales have neither been designed for use with industrial employees in SMEs[3] , nor are they based on theoretically sound models (see in detail in chapter 2.4). Therefore, both Cerasoli et al. (2018) and Jeong, Han, Lee, Sunalai, and Yoon (2018) point to the need for research to develop a valid and theoretically sound measurement instrument. The first manuscript of this work-"Informal Workplace Learning: Development and Validation of a Measure" (Decius et al., 2019)-addresses this research desideratum and presents a scale to capture informal workplace learning among industrial workers. This scale refers to the octagon model of informal learning as its theoretical foundation, which was developed as part of the study as an extension of the dynamic model of informal learning (Tannenbaum et al., 2010).

Having thus shown a way to make informal learning measurable among industrial employees in SMEs, the following second question then arises:

Which constructs are antecedents of informal learning in the workplace, i.e., precede and thus predict informal learning, and which constructs are outcomes of informal learning, i.e., follow from informal learning?

In order to promote informal learning in the company in the best possible way, it is important to know which constructs determine informal learning. In general, research distinguishes between personal and organizational antecedents (Cerasoli et al., 2018; Tannenbaum et al., 2010). From the perspective of companies, the organizational framework conditions of informal learning represent the greater lever in this context, as these can be influenced directly or at least indirectly through interventions (e.g., social support by raising awareness among supervisors, work requirements by restructuring work processes). In contrast, personal characteristics such as personality factors, which can after all be regarded as relatively stable over short to medium-term periods (Herzberg & Roth, 2014), or attitudes and motivational factors such as learning goal orientation can hardly be influenced. Alternatively, individuals with

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[3] Jeong, McLean & Park (2018 , p. 90) emphasize that the extent of informal learning depends on the size of the company; however, too little is known about how informal learning actually takes place in SMEs.

characteristics that are conducive to learning can be accumulated in the company over the long term by means of adapted strategic personnel selection, if the labor market permits this (cf. Decius, Schaper & Seifert, 2020[a]). Although both personal and organizational antecedents are considered important at the same time in the context of informal learning (Tannenbaum et al., 2010), previous research often limited itself to a separate consideration, overemphasizing either the importance of personal or organizational determinants (Jeong, Han et al., 2018). Noe et al. (2014) therefore encourage more research on the antecedents and learning-enhancing conditions of informal learning.

The existing body of research on the outcomes and consequences of informal learning is similarly fragmented (see, e.g., Noe et al., 2014). In principle, learning outcomes can be defined as lasting changes in knowledge, skills, and attitudes as a result of participation in learning activities (Kraiger, Ford & Salas, 1993). The consensus of research to date is limited to the fact that contextual learning outcomes should always be considered (Ellinger, 2005; Froehlich, Segers & Van den Bossche, 2014; Kyndt, Gijbels, Grosemans & Donche, 2016). Especially for human resource development in SMEs, it is of great importance whether - and if so - which results can be expected from the promotion of informal learning at the workplace, also against the economic background of the return on investment of a measure to be considered. Therefore, more research on the consequences of informal learning is advised (e.g., Cerasoli et al., 2018; Noe et al., 2014).

The meta-analysis by Cerasoli et al. (2018) does include personal and organizational antecedents and learning outcomes together. However, this only considered individual correlations of the constructs with informal learning; moreover, the meta-analysis necessarily relied on studies in which informal learning was operationalized inconsistently and often without a conceptual basis due to the lack of definitional consensus (Decius et al. , 2020[a]). While the study by Choi and Jacobs (2011) also examines the simultaneous relationships among personal characteristics, work environment characteristics, and informal learning. However, to simplify the calculation of their structural model, the authors combined all personal constructs on the one hand and all work environment constructs on the other into a total score, so that no statements can be made about individual factors. Furthermore, no learning outcomes are taken into account.

The second manuscript of this work - "Work Characteristics or Workers' Characteristics? An Input-Process-Output Perspective on Informal Workplace Learning of Blue-Collar Workers" (Decius et al., 2020[a]) - is therefore devoted to exploring the personal and organizational

antecedents and outcomes of informal learning[4] in a holistic empirical structural model. In this regard, this structural model is based on the APO (*Antecedents, Processes and Outcomes* Framework) for informal learning among industrial workers, which was previously developed in the context of the study and is based on the theoretical framework of Cerasoli et al. (2018). It should be noted that the study uses a cross-sectional research design, so while the constructs are arranged in an input-process-output model based on conceptual considerations, the results do not allow for the derivation of causal interpretations (cf. Maxwell & Cole, 2007). Rather, the study provides the correlative foundation upon which further longitudinal studies can be built (cf. Spector, 2019).

Accordingly, the third question focuses on the causality of the relationship of informal learning and putative antecedents:

What are the interactions between working conditions (exemplified by job demands and decision-making latitude) and informal learning in the workplace over time?

The aforementioned question addresses a research gap that was not perceived as such for a long time. The vast majority of research in work-based learning has assumed that job characteristics such as job autonomy and job demands influence employee learning and development (e.g., Cerasoli et al., 2018; Kyndt & Baert, 2013; Noe et al., 2014; Parker's work-design-growth model, 2017). Often, this assumption is rooted in theoretical models such as the job demand-control model and its successor, the demand-control-support model (Karasek, 1979; Karasek & Theorell, 1990). According to the "active learning hypothesis" from these models, learning and personal growth occur primarily in "active jobs" that have both high job demands and high control over one's own work (i.e., for example, decision latitude). There is much empirical evidence for this hypothesis, but it is based almost exclusively on cross-sectional studies and thus does not allow for causal interpretations - the few longitudinal studies did not yield clear findings (see the reviews by Taris & Kompier, 2004, and by Wielenga-Meijer, Taris, Kompier & Wigboldus, 2010). Nevertheless, the causal direction of action between work characteristics and learning has hardly been questioned, with the exception of a study by De Lange et al. (2010), which, however, did not provide clear evidence. In addition to the "active learning hypothesis," the team of authors also examined the alternative "active shaper hypothesis." This hypothesis builds on the job crafting theory (Wrzesniewski & Dutton, 2001) and assumes that in the long term learners want to use and expand their work resources more

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[4] Within the manuscript, a comprehensive presentation of possible antecedents and learning outcomes as well as a weighing discussion regarding their relevance in the context of informal learning among industrial employees in SMEs is provided.

effectively, such as the scope for decision-making, on the one hand, and make their work more interesting and challenging on the other, which is associated with increasing demands (De Lange et al., 2010).

In the context of informal learning, no longitudinal studies on the causal relationship with work characteristics are available to date. Instead, other aspects of learning such as the availability of learning opportunities, motivation to learn, or problem solving in the work process have been considered in the past (for an overview, see Decius, Schaper & Seifert, 2020[b]). Overview studies such as those by Cerasoli et al. (2018) and by Noe et al. (2014) therefore explicitly call for more longitudinal research on informal learning in the workplace in order to examine previously exclusively correlationally verified relationships over time and to reach causal conclusions.

The question of causality is also of great importance for practice - after all, it makes a crucial difference whether working conditions influence informal learning ("active learning hypothesis") or whether informal learning influences working conditions ("active adaptation hypothesis"). If exclusively the first case were to receive empirical evidence, HR managers in SMEs could promote informal learning by adapting working conditions, for example, by providing more scope for decision-making while simultaneously increasing work requirements (cf. also the German-action theory of Frese and Zapf, 1994). With exclusive evidence for the second case, this would not be possible: a pessimistic view would be that the provision of decision latitude would be overestimated; an optimistic view would emphasize that the promotion of informal learning in the workplace would have positive long-term effects on the proactivity and willingness of workers to take responsibility (Decius et al., 2020[b]).

The third manuscript of this paper - "Do Job Demands and Job Control Lead to Informal Workplace Learning, or Vice Versa? A Cross-Lagged Panel Analysis " (Decius et al., 2020[b]) - thus addresses the "chicken-and-egg" problem of informal workplace learning: are working conditions the determinant starting point, or is it informal learning? Methodologically, a structural equation model with a cross-lagged panel design and a time interval of 1.5 years between the two measurement points is used.

1.5   Structure of the present work

In summary, this research consequently deals with how informal learning among industrial employees in SMEs can be conceptualized and operationalized. In addition, it examines which antecedents and learning outcomes are associated with informal learning and - taking working conditions as an example - how these constructs, located in the nomological network of informal learning, interact with informal learning in a longitudinal context.

In order to be able to answer the research questions raised in a valid and theoretically sound manner, it is necessary to first deal more intensively with the background of informal learning. Therefore, in the following, the development of research on informal learning in the workplace is traced historically; furthermore, diverse definitions and conceptualizations of informal learning are contrasted and compared in terms of content. Various published scale-based measurement instruments for operationalizing informal learning are presented and analyzed, as are classifications of antecedents and outcomes of informal learning. Subsequently, the term *learning form is* defined, and seven dimensions are used to analyze whether various learning concepts widely used in the literature[5] *are learning forms*. These learning forms are distinguished from learning form *informal learning* and located in a structural overview (as suggested e.g. by Bell et al., 2017). This is followed by a summary of the methodology and results of the above-mentioned manuscripts to answer the research questions, and finally a discussion of the strengths and limitations of the individual studies, along with an explanation of the theoretical and practical implications of the study results.

2. Theoretical approaches to informal learning

2.1   Conceptual history of informal learning

Informal learning has an extensive history: The beginnings of the construct can be traced back to the end of the 19th century. The American philosopher and educator John Dewey, a professor at the University of Chicago, used the term "informal education"[6] in his 1898/1899 lecture series, as revealed in his students' syllabus notes (Rohs, 2016). In his published works, Dewey (1916, 1938) eventually introduced the idea to research that learning from one's own experiences, in addition to learning in school, plays an important role in education. American philosopher Mary Parker Follett (1918) broadened the context of informal education-although without using the term-from school to include all areas of everyday life and referred to education as a continuous life task (Rohs, 2016). Building on this work by Dewey and Follett, American educator Eduard C. Lindemann first used the term "informal learning" (1926).

The topic of informal continuing education gained greater prominence through the work "Informal adult education" by Malcolm S. Knowles (1950), in which he emphasized its

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[5] The term "learning concept" is used in this research as a collective term for various approaches to vocational (continuing) education described in the literature.

[6] The term "education" refers to the entire education system, while the term "learning" refers to the individual (Werquin, 2016, p. 41). In some cases, the terms "informal education" and "informal learning" are used synonymously, which is clearly criticized by Overwien (2007) , for example.

advantages over formal continuing education. Like Dewey and Lindemann before him, Knowles emphasized personal experiential learning as a source of learning. In the 1970s, informal learning increasingly entered the sociopolitical debate. It was seen as a viable alternative to widespread formal continuing education, as "criticism [was] raised that formal education not only imparts the wrong skills, but also fails to redress social and economic inequalities in developing countries" (Rohs, 2016, p. 15). In this context, it is worth mentioning, for example, the works of Coombs (1968) and Faure et al. (1972), which were produced in the context of UNESCO, and Coombs and Ahmed (1974), commissioned by the World Bank ("Attacking rural poverty"; see Werquin, 2016). At the same time, Tough (1971) conducted the first empirical research on the prevalence of informal education and concluded that 80% of learning does not take place in formal settings.

Finally, Marsick and Watkins (1990) are considered to be the founders of the modern understanding of the term informal learning, who for the first time established a model for conceptualization[7] . Before this model and two other models are described in more detail (see chapter 2.3), the present work is first devoted to the various definitions of informal learning that have emerged in research since the much-noted "milestone" of Watkins and Marsick.

2.2   Definitions of informal learning

In the course of the theoretical-conceptual discourse on informal learning in the last decades, quite a few definitions of this concept have been introduced into the scientific discussion. Especially in the "peak phase" at the end of the 1990s and the beginning of the 2000s (see Table 1), many definitions with partly different emphases were established. For almost as long, scholars have been calling for a standardization of the terms used and a definitional consensus (e.g., Bell et al., 2017; Dohmen, 2001; Overwien, 2009; Werquin, 2016) - but so far with rather moderate success. In addition, the rising popularity of the term "informal learning" in organizational practice contributed to inconsistent use of the construct.

The theoretical and empirical research on informal learning in the workplace has often been described in the literature as "under-researched" (Eraut, 2004, p. 247) and, to a large extent, "anecdotal" (Noe et al. , 2013, p. 327). An example of such anecdotal learning is the metaphor of locomotion: Whereas formal learning can be likened to a bus ride-the route is predetermined and the same for all passengers-informal learning is more like a bicycle ride, where the person riding, for example, can determine the route and speed individually (Cross, 2007, in Berg & Chyung, 2008, p. 230).

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[7] Marsick (1987, p. 21) already uses the term "informal learning" in reference to Schön's (1983) "reflection-in-action" concept, but does not elaborate on it below.

While Garrick (1998) describes informal learning as an elusive, discursive construct (p. 124), others have sought to frame the construct more clearly. However, as Billett (2002) criticizes, many definitions in the field of workplace-based learning include *negative* formulations, which he sees as imprecise and unhelpful. For example, Marsick and Volpe (1999) describe informal learning as "unstructured" and "noninstitutional" (p. 4). Hoffman (2005, p. 1) - in an effort to find a simple description - even goes so far as to view informal learning as anything that is not identifiable as formal training and performance support. Even such a crude understanding of the construct is unhelpful, but serves as an example of the heterogeneity in definitions found in the literature. It is not without reason that Werquin (2016, p. 49) points out that - in addition to the intentionality of learning and whether the learning outcome leads to certification - the definitional breadth of the concept is the main differentiating criterion when considering different definitions of informal learning.

In the following, different definitions of informal learning are mentioned and compared. As a result of an extensive literature search, Table 1 shows a total of 21 definitions of informal learning in chronological order, spanning a period from 1990 to 2018.

Table 1 Chronological overview of the definitions of informal learning**.**

Authors	Year	Definition of informal learning in wording
Marsick & Watkins	1990	Informal learning "may occur in institutions, but it is not typically classroom-based or highly structured, and control of learning rests primarily in the hands of the learner. [...] Informal learning can be deliberately encouraged by an organization or it can take place despite an environment not highly conducive to learning" (p. 12).
Dale & Bell	1999	"Informal learning: Learning which takes place in the work context relates to an individual's performance of their job and/or their employability, and which is not formally organized into a program or curriculum by the employer. It may be recognised or unrecognised by the different parties involved, and may or may not be specifically encouraged" (p. i).
Livingstone	1999	"Informal learning is any activity involving the pursuit of understanding, knowledge or skill which occurs outside the curricula of educational institutions, or the courses or workshops offered by educational or social agencies. The basic terms of informal learning (e.g., objectives, content, means and processes of acquisition, duration, evaluation of outcomes, applications) are determined by the individuals and groups that choose to engage in it. Informal learning is undertaken on one's own, either individually or collectively, without either externally imposed criteria or the presence of an institutionally authorized instructor" (p. 51).
Marsick & Volpe	1999	"Informal learning is integrated with work and daily routines, is triggered by an internal or external jolt, is not highly conscious, is haphazard and influenced by chance, is an inductive process of reflection and action, is linked to learning of others" (p. 5).

European Commission	2001	Informal learning is defined as "learning resulting from daily life activities related to work, family or leisure. It is not structured (in terms of learning objectives, learning time or learning support) and typically does not lead to certification. Informal learning may be intentional, but is in most cases non-intentional" (p. 32; in Skule, 2004, p. 9).
Kirchhof & Kreimeyer	2003	"Informal learning consequently consists of actions consciously intended as learning processes (self-organized learning) and experiences perceived as such (experiential learning) as well as learning processes of which the learners are not aware of the course and outcome (implicit learning). The constituting common feature of such informal learning processes is precisely the absence of any pedagogical intention and influence" (p. 219).
Eraut	2004	Informal learning is defined "as learning that comes closer to the informal end than the formal end of a continuum. Characteristics of the informal end of the continuum of formality include implicit, unintended, opportunistic and unstructured learning and the absence of a teacher. In the middle come activities like mentoring, while coaching is rather more formal in most settings" (p. 250).

Authors	Year	Definition of informal learning in wording
Churchhöfer	2004	"The term informal learning refers to learning processes that are anticipated, self-organized, and reflected upon by the subject as learning, require a time of their own and directed attention, are tied to problem situations, but are not tied to an institution" (p. 85).
Lohman	2005	"Informal workplace learning is defined as an aspect of workplace learning that specifically involves those learning activities that employees initiate in the workplace; involve the expenditure of physical, cognitive, or emotional effort; and result in the development of professional knowledge and skills" (pp. 502-503).
Molzberger	2008	"Informal learning is a subjective appropriation process in social and situational context [sic]. An important characteristic of informal learning in the forms of reflective learning, experiential learning, and implicit learning is the lack of long-term, constant, professional support for the learning processes" (p. 86).
Tannenbaum, Beard, McNall & Salas	2010	"Informal learning has several common characteristics: [it] is predominantly learner directed and self-guided (i.e., individually not organizationally controlled); reflects at least some intent for development, growth, learning, or improvement (i.e., it is not simply incidental learning); involves some action and doing, and is not purely educational (e.g., not reading or training); does not occur in a formal learning setting (e.g., not classroom or e-learning)" (p. 306).
Choi & Jacobs	2011	"Informal learning occurs as the result of individuals' making sense of the experiences they encounter during their daily work. Informal learning is not intentionally structured; the control of learning is in the hands of the learners" (p. 241).
Kock & Ellström	2011	"Informal learning in the daily work, that is, learning through participation in development projects, staff-meetings, job rotation, team-based work, etc.". As used here, informal learning refers to learning that occurs regularly in work as well as in everyday life, but subordinated to other activities (e.g. work

practices) in the sense that learning is not their primary goal. That is, learning while you are primarily focused on performing another task. As a learning process, informal learning in and through the daily work is characterized by a low degree of planning and organising" (p. 73).

UNESCO Institute for Statistics	2012	"Informal learning is defined as forms of learning that are intentional or deliberate, but are not institutionalized. It is consequently less organized and less structured than either formal or non-formal education. Informal learning may include learning activities that occur in the family, workplace, local community and daily life, on a self-directed, family-directed or socially-directed basis. Like formal and non-formal education, informal learning can be distinguished from incidental or random learning" (p. 12).
Mulder	2013	"Informal learning is defined here as cognitive and physical learning activities (that lead to cognitive activities) that can be deliberate or reactive, and that lead to competences but not to formal qualifications. It can happen individually or in social interaction, at work in a non-organized manner (outside organized learning/training settings)" (p. 52).

Authors	Year	Definition of informal learning in wording
Kyndt & Baert	2013	"Informal learning is characterized by a low degree of planning and organizing in terms of the learning context, learning support, learning time, and learning objectives. Informal learning opportunities are not restricted to intentionally created learning environments but can occur during several on- and off-the-job (work-related) activities. The learning results from engagement and reflection in daily work-related activities in which learning is not the primary goal. Informal learning is undertaken autonomously, either individually or collectively, but without an instructor or trainer. It often happens spontaneously and unconsciously. From the learner's perspective, it is unintentional, although a basic attitude of 'willingness to learn' can benefit learning processes and outcomes" (p. 274).
Noe, Tews & Marand	2013	Informal learning "includes cognitive activities and behaviors that are self-focused and other-focused [...] These activities and behaviors can be categorized into three dimensions: learning from oneself, learning from others, and learning from non-interpersonal sources. Learning from oneself includes spending time reflecting how to improve one's performance and experimenting with new ways of performing. Learning from others includes interacting with peers and superiors to solicit feedback on ideas and devise strategies for performance improvement. Learning from non-interpersonal sources includes reading trade publications and searching the internet for useful resources and information" (p. 328).
Stretch Bostel	2015	"Informal learning at work is learning about experiences made in and about work actions. It results from work and action requirements and is not institutionally organized; it produces a learning outcome that emerges from situational coping and problem solving in work or from actions; it is generally not professionally accompanied pedagogically" (p. 38).
Watkins & Marsick	2016	Informal learning occurs "from and through experience; often socially, through interaction with others; intertwined with work, that is, hard to separate from the task that prompts it, e.g., solving problems or trial-and-

		error; tied by its nature to the opportunities provided through tasks, processes, roles and settings" (p. 265).
Cerasoli et al.	2018	"Informal learning behaviors (ILBs) are non-curricular behaviors and activities pursued in service of knowledge and skill acquisition that take place outside formally-designated learning contexts. Such activities are predominantly self-directed, intentional, and field-based. Informal learning behaviors are not syllabus-based, discrete, or linear" (p. 204).
Wolfson, Tannenbaum, Mathieu & Maynard	2018	Informal field-based learning is defined as "engaging in intentional self-directed behaviors aimed at learning new, work-oriented, and organizationally valued content outside of a formal learning program. Our conception includes three types of intentional behaviors: (1) experimentation/new experiences (e.g., seeking new assignments, doing a task differently), (2) feedback/reflection (e.g., actively seeking feedback and advice; debriefing work experiences), and (3) vicarious learning behaviors (e.g., intentionally observing others and talking with them about their work)" (pp. 16-17).

Including the early publication by Marsick and Watkins (1990), the ten definitions in the period 1999 to 2008 are classified as older definitions, and the eleven definitions in the period 2009 to 2018 are classified as newer definitions[8] . Four of the 21 definitions are in German, the remaining 17 are in English.

In the following, the definitions are compared on the basis of their definitional constituents. The constituents can be inductively divided into seven categories: (1) structure and place of learning; (2) self/external control; (3) processual elements of learning; (4) learning outcome; (5) intentionality; (6) trigger/goal; (7) social embeddedness. Tables 2-8 show for each category which characteristics the respective definitions attribute to informal learning.

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[8] There is a gap in the definitional chronology between 1990 and 1999, from which time no relevant definitions of informal learning could be located.

Table 2: Characteristics and assigned studies of the definitional category "structure and place of learning".

nicht formal/institutionell organisiert	wenig strukturiert	vorkommend in täglichen Arbeitsprozessen	auch von Organisationen förderbar
Marsick & Watkins, 1990	Marsick & Watkins, 1990	Marsick & Volpe, 1999	Marsick & Watkins, 1990
Dale & Bell, 1999	Europäische Kommission, 2001	Europäische Kommission, 2001	Dale & Bell, 1999
Livingstone, 1999	Eraut, 2004	Choi & Jacobs, 2011	
Kirchhöfer, 2004	Kock & Ellström, 2011	Kock & Ellström, 2011	
Tannenbaum et al., 2010	UNESCO-Institut für Statistik, 2012	UNESCO-Institut für Statistik, 2012	
UNESCO-Institut für Statistik, 2012	Kyndt & Baert, 2013	Kyndt & Baert, 2013	
Mulder, 2013	Cerasoli et al., 2018	Watkins & Marsick, 2016	
Cerasoli et al., 2018		Cerasoli et al., 2018	
Wolfson et al., 2018			

The criteria of the category "structure and place of learning" as well as the assigned publications can be found in table 2. Nine authors[9] assume that informal learning is not formally or institutionally organized. This includes that learning is not classroom-based (Marsick & Watkins, 1990; Tannenbaum et al., 2010) and occurs outside of a curriculum (Cerasoli et al., 2018; Livingstone, 1999). However, Marsick and Watkins (1990) and Dale and Bell (1999) state that although informal learning occurs in non-learning environments, it can also be fostered by organizations. It is noticeable that this view is not expressed in later definitions.

Seven authors describe informal learning as having little to no structure. In addition to these negative definitions, i.e. which characteristics informal learning *does not* possess, eight authors describe in their definitions that informal learning results from daily work processes and routines.

Overall, the structure of informal learning is taken up in 70% of the older definitions and in just over 80% of the newer ones. Furthermore, only one of the four German-language sources (Kirchhöfer, 2004) is dedicated to this category.

Table 3: Characteristics and assigned studies of the definitional category "self/external control".

Self-control and self-direction	Lack of pedagogical support & guidance
Marsick & Watkins, 1990	Livingstone, 1999

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[9] In some cases, these are also teams of authors or institutions that have written the definitions. For the sake of simplicity, we will refer to these authors only here and in the following.

Livingstone, 1999	Kirchhof & Kreimeyer, 2003
Churchhöfer, 2004	Eraut, 2004
Lohman, 2005	Molzberger, 2008
Molzberger, 2008	Tannenbaum et al., 2010
Tannenbaum et al., 2010	Kyndt & Baert, 2013
Choi & Jacobs, 2011	Stretch Bostel, 2015
UNESCO Institute for Statistics, 2012	
Kyndt & Baert, 2013	
Cerasoli et al, 2018	
Wolfson et al, 2018	

The criteria of the category "self-/self-directed" as well as the assigned publications can be found in table 3. Eleven authors define informal learning as a self-organized or self-directed (e.g., Tannenbaum et al., 2010) or learner-initiated (Kyndt & Baert, 2013; Lohman, 2005) and controlled (Choi & Jacobs, 2011; Marsick & Watkins, 1990) activity. Seven authors highlight the lack of pedagogical support in the learning process (e.g., Molzberger, 2008) and specifically emphasize that no institutional teacher is involved (e.g., Livingstone, 1999).

Self-direction of learning is mentioned in 70% of the older definitions and just over 60% of the newer definitions. Moreover, this category plays a role in all four German-language definitions.

Table 4: Characteristics and assigned studies of the definitional category "Processual elements of learning".

(only) experience/action	Reflection (only)	Experience/Action & Reflection
Kirchhof & Kreimeyer, 2003	Churchhöfer, 2004	Marsick & Volpe, 1999
Stretch Bostel, 2015		Lohman, 2005
Watkins & Marsick, 2016		Molzberger, 2008
		Tannenbaum et al., 2010
		Choi & Jacobs, 2011
		Kyndt & Baert, 2013
		Mulder, 2013
		Noe et al., 2013
		Wolfson et al, 2018

The criteria of the category "Processual elements of learning" as well as the assigned publications can be found in table 4. Three authors see learning from experience in particular

as the main component of informal learning. Only one author (Kirchhöfer, 2004) focuses on reflection as the main component. The majority, namely nine authors, describe informal learning as a process that includes actions and experiences as well as reflection. For example, Mulder (2013) assumes that a physical activity subsequently leads to a cognitive activity. Lohman (2005) emphasizes the physical, cognitive, and emotional effort involved in learning.

50% of the older definitions deal with the processual elements of learning; for the newer definitions it is just over 70%. All four German-language definitions refer to this category.

Table 5: Characteristics and assigned studies of the definitional category "learning outcome".

Acquisition of competencies	Situation Management	No certification
Lohman, 2005	Stretch Bostel, 2015	European Commission, 2001
Mulder, 2013	Wolfson et al, 2018	Mulder, 2013

The criteria of the category "learning outcome" as well as the assigned publications can be found in table 5. In contrast to the previous categories, the criteria from this category are mentioned less frequently in the definitions of informal learning. Two authors (Lohman, 2005; Mulder, 2013) highlight that informal learning results in the development of knowledge and skills or competencies. Others highlight that learning aims at a work-related outcome that is valuable to the organization (Wolfson et al., 2018) or contributes to coping with situations and solving problems (Dehnbostel, 2015). Twice, the definitions also mention that informal learning does not lead to certification (European Commission, 2001; Mulder, 2013). However, some authors critically note that concepts such as informal learning should be defined independently of whether programs exist to recognize acquired competencies and learning outcomes (Rohs, 2007, p. 29; Werquin, 2016, p. 59)[10] . Possibly, this view is one reason that the lack of certification of learning is hardly part of scientific definitions, although this aspect plays an important role in practice-related descriptions of informal learning.

Overall, only 20% of older definitions and about 30% of newer definitions include learning outcome information, including one of the four German-language sources (Dehnbostel, 2015).

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[10] Rohs (2007) cites two specific reasons here: "Firstly, because it is not (and cannot be) precisely described what a *recognized* qualification is and what *value* is to be attached to the certificate. On the other hand, a degree or certificate can be awarded without making any statements about the learning process. For example, certificates can be obtained on the Internet through online tests without corresponding courses" (pp. 29-30).

Table 6: Characteristics and assigned studies of the definitional category "intentionality".

both possible: conscious/intentional or unconscious/non-intentional	only conscious/intentional	(rather) unconscious/non-intentional
Dale & Bell, 1999	Livingstone, 1999	Marsick & Volpe, 1999
European Commission, 2001	Churchhöfer, 2004	Eraut, 2004
Kirchhof & Kreimeyer, 2003	Tannenbaum et al., 2010	Choi & Jacobs, 2011
Molzberger, 2008	UNESCO Institute for Statistics, 2012	
Kyndt & Baert, 2013	Mulder, 2013	
	Cerasoli et al, 2018	
	Wolfson et al, 2018	

The criteria of the category "Intentionality" as well as the assigned publications can be found in Table 6. A three-way split can be observed in this category.

The majority of authors, namely seven, describe informal learning as a conscious or intentional process. Some even explicitly exclude incidental learning (Tannenbaum et al., 2010; UNESCO Institute for Statistics, 2012). Mulder (2013) also excludes incidental learning, but distinguishes between deliberate and reactive learning, with the latter assumed to be less intentional than the former.

Only three authors assume that informal learning takes place unconsciously or non-intentionally - with Choi and Jacobs (2011) referring to the fact that learning is not *structured* intentionally, and Marsick and Volpe (1999) speaking of learning that is not particularly conscious. Only Eraut (2004) clearly emphasizes what he considers the implicit and non-intentional character of informal learning.

Five authors do not specify with regard to intentionality, use a broad definition and speak of conscious *or* unconscious or intentional *or* non-intentional learning. Furthermore, Molzberger (2008) mentions that implicit learning is part of informal learning.

Of the older definitions, 80% and of the newer definitions just over 60% include a statement on the intentionality of learning. This is also the case in three of the four German-language definitions (apart from Dehnbostel, 2015). However, an interesting trend emerges in terms of timeliness: of the eight older definitions that address intentionality, two advocate awareness or intentionality of learning. Two others vote against it, and four do not commit themselves but attribute to informal learning to be partly both conscious or intentional and unconscious or non-intentional. Of the seven recent definitions that make a statement about intentionality, five describe learning as conscious or intentional, and only one definition each

as non-intentional and as not clearly determined. This suggests that research in recent years has agreed that informal learning has an intentional component. Dohmen (2018) puts it succinctly: informal learning is "about 'learning,' that is, the *understanding-seeking* constructive processing of information and experience. This excludes, for example, unconscious socialization processes" (p. 52).

Table 7: Characteristics and assigned studies of the definitional category "trigger/target".

Goal: Action/problem solving
Churchhöfer, 2004
Kock & Ellström, 2011
Kyndt & Baert, 2013
Stretch Bostel, 2015
Watkins & Marsick, 2016

The criteria of the category "trigger/goal" as well as the assigned publications can be found in table 7. Only in a few definitions a trigger or a goal of learning is mentioned - in 10 % of the older and slightly more than 30 % of the newer definitions, but in no less than two of the four German-language definitions. The five authors state that informal learning is linked to problem situations or results from work and action requirements (Dehnbostel, 2015; Kirchhöfer, 2004; Watkins & Marsick, 2016), and that learning is not the goal of the action, but attention is focused on the task (Kock & Ellström, 2011; Kyndt & Baert, 2013).

Table 8: Characteristics and assigned studies of the definitional category "social inclusion".

both possible: individual or collective	special mention of social inclusion
Livingstone, 1999	Marsick & Volpe, 1999
Kyndt & Baert, 2013	Molzberger, 2008
Mulder, 2013	UNESCO Institute for Statistics, 2012
Noe et al., 2013	Watkins & Marsick, 2016
Wolfson et al, 2018	

The criteria of the category "social embeddedness" as well as the assigned publications can be found in table 8. While some definitions show no reference to the social context, Noe et al. (2013), for example, describe informal learning as an activity directed toward oneself or toward others. A total of five authors suggest that informal learning can occur both individually and collectively. Others, however, emphasize the social embeddedness of learning (Marsick & Volpe, 1999; Molzberger, 2008), mention exemplary social contexts (UNESCO Institute

for Statistics, 2012), or at least talk about informal learning being "often" socially situated and occurring through interaction (Watkins & Marsick, 2016).

While only 30% of the older definitions include social embeddedness, the proportion is over 50% in the newer definitions. Only one of the German definitions (Molzberger, 2008) explicitly addresses the social context of learning.

Even though informal learning has been defined by different authors over the last decades, the analysis of the 21 available definitions shows certain consistent characteristics, which are mentioned below:

Informal learning

- is not formally or institutionally organized
- Is little structured
- Occurs in everyday work processes and situations
- is controlled and managed by the learner him/herself
- is not pedagogically supported or accompanied
- includes learning from experiences and actions as well as reflection
- is a conscious or intentional process
- has an action or problem solving as its goal, not learning itself
- is often embedded in a social context.

Although there seems to be an abundance of definitions of informal learning rather than a shortage, this is not true of models of informal learning that conceptually describe and explain the process or components. The only approaches worth mentioning here are those of Marsick and Watkins (1990), Tannenbaum et al. (2010), and Decius et al. (2019). These models are presented in more detail below.

2.3   Models of informal learning

2.3.1   *Marsick and Watkins' (1990) model of informal and incidental learning in the workplace.*

In developing their model of informal and incidental[11] learning, Watkins and Marsick (1990) referred on the one hand to the concept of experiential learning ("experiential learning"; Kolb, 1984; see in detail in chapter 3.3.7) with its cyclical sequence of experience and reflection, which in turn is based on Dewey's (1938) pragmatic cycle of problem solving through reflective thinking (cf. Marsick, Watkins, Callahan & Volpe, 2009). Second, they adopted the idea of "double-loop learning" from Argyris and Schön's (1978) organizational action theory, which is rooted in Lewin's (1947) action research.

According to Argyris and Schön (1978, 1996), in single-loop learning, a problem or error that occurs is noticed during the action. To solve the problem, the action is reflected upon and

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[11] Marsick and Watkins (1990) consider incidental learning as a subcomponent of informal learning. This thesis does *not subscribe to* this view, as will be explained in detail in Section 3.3.3. The work of Marsick and Watkins is primarily seen as an approach to conceptualizing informal learning processes.

then an alternative method or strategy is used to achieve the goal of the action. Often, however, the person remains in the thought patterns he or she learned earlier and merely pretends to follow a certain strategy. This is called "espoused theory" and refers to the (action) theory held by the person. This is contrasted with the strategy actually implicitly pursued by the person, which is called the "theory-in-use," i.e., the action-guiding (action) theory. In the more complex "double-loop learning," the goal behind the action is questioned after the problem has occurred, and thus the ideas, values, and assumptions associated with it are reflected upon. One result of this reflection could be, for example, instead of changing the strategy to the previous goal, to focus on a new goal[12] . Through reflection, the person can also become aware of the discrepancy between the supposedly pursued "espoused theory" and the actually pursued "theory-in-use".
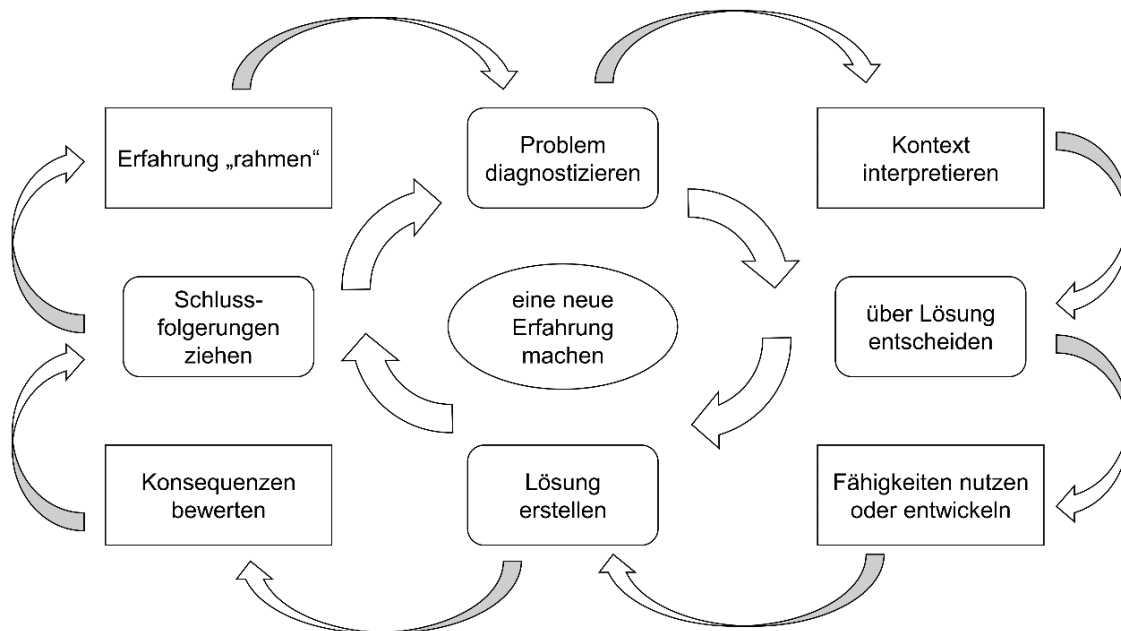
Figure 1: Marsick & Watkins' model of informal and incidental learning in the workplace (adapted from Marsick, Watkins, Callahan & Volpe, 2009, p. 577).

Marsick and Watkins' model (see Figure 1) depicts an interactive cycle of learning from experience that begins with an unfamiliar challenge or problem that triggers the learning process (Marsick & Watkins, 2018; Marsick et al., 2009). The learning cycle[13] can be divided into four steps of problem solving, which are arranged in the model on the horizontal as well as vertical axis, and four learning steps, which are located in the four corners of the model. Thus,

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[12] Ashby (1952) uses the metaphor of a heating thermostat for this: "single-loop learning" refers to the way the set temperature can be achieved; "double-loop learning" refers to whether the set temperature was chosen at all sensibly (cf. Marsick & Watkins, 1990, p. 18).

[13] The description of the learning cycle is based on the work of Marsick et al, 2009, pp. 577-578.

one learning step is located between each two problem-solving steps. Problem solving begins with a problem diagnosis, in which the learner draws on similarities and differences of the situation to previous experiences. Following the diagnosis, the learning person seeks to learn more about the context of the challenge, and to understand the "political dimension" of the problem. To do this, she may also, for example, seek information from other people or social groups and match it with her own thinking, resulting in a number of alternative courses of action. Finally, the person chooses one of the alternative actions. To perform the selected action or implement the solution, she relies on her existing competencies or develops new skills, abilities, and application-related knowledge as needed. This is followed by the solution application phase, which is followed by the evaluation of the consequences that result from the selected alternative action. In particular, the focus here is on whether the goals of the problem solution were achieved. More difficult to grasp, but no less important, is to identify the non-intended consequences from the action. On the basis of the evaluation result, the learning person draws conclusions and links his newly learned experiences ("lessons learned") with his previous knowledge.

Although Marsick and Watkins (2018) emphasize that numerous studies have confirmed their model, in this and other contributions they almost exclusively cite unpublished doctoral theses as evidence (cf. also Marsick & Watkins, 2001; Watkins, Marsick, Wofford & Ellinger, 2018), which are thus not amenable to review. Moreover, the evidence seems to be mainly qualitative case studies (cf. Marsick et al., 2009, p. 579) - quantitative empirical evidence on the assumptions resulting from the model does not seem to be available so far.

In several later contributions, the authors emphasize that the context and social embeddedness of informal learning play a stronger role than was the case in their original model (Cseh, Watkins & Marsick, 1999; Marsick & Neaman, 2018; Marsick et al., 2009; Marsick, Watkins & Lovin, 2010; Watkins et al., 2018). Marsick et al. (2009) note that the basic cycle of problem-solving and learning steps, while still relevant, is of limited use as a framework model when many learners are interacting and simultaneously pursuing both individual and organizationally determined goals. Therefore, they argue, it is appropriate to view learning as a multidimensional process of iterative cycles in which a constant "back and forth" between phases is possible. Thus, the authors conclude, "Such a dynamic process is hard to capture in a model" (p. 591). One could assume that this statement inspired Tannenbaum and his colleagues - only one year later (2010) these researchers presented the "Dynamic Model of Informal Learning", which will be examined in more detail in the following.

2.3.2   *The dynamic model of informal learning by Tannenbaum, Beard, McNall,*
and Salas (2010).

Tannenbaum et al. (2010), following experiential learning (Kolb, 1984) and Marsick and Volpe's (1999) definition, understand informal learning as predominantly self-directed, intentional, building on an action or activity, and not occurring in formal learning environments (p. 306). To conceptualize informal learning, the authors present a model with four components that represent the components of learning (see Figure 2)[14] : learning intention ("Intent to learn, improve, and develop"), experience and action ("Experience and action"), feedback, reflection.

- The learning intention component means that the learner is or becomes aware of a need to improve his or her actions or performance prerequisites (competencies). This may be a specific problem-solving intention or a more general need to acquire new knowledge and build expertise.

- The experience and action component involves the learner's engagement in an experience, action, or task in which the learner is actively engaged in an activity.

- The feedback component involves receiving feedback related to an event or activity. Feedback could arise directly from the task or come from other people. It can also be directly directed at the learner, or it can be vicarious[15] .

- The "reflection" component refers to the learner engaging in careful and comprehensive reflection to derive experiential values from their actions.

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[14] The description of the model is based on the work of Tannenbaum et al, 2010, pp. 306-311.

[15] Tannenbaum et al. (2010, p. 310) give the following examples of direct and vicarious feedback (translated by the author of this paper): "Next time you should check the equipment before you start the system" (direct); "Once I failed to check the equipment, we had to shut down the system right after we started it" (vicarious).
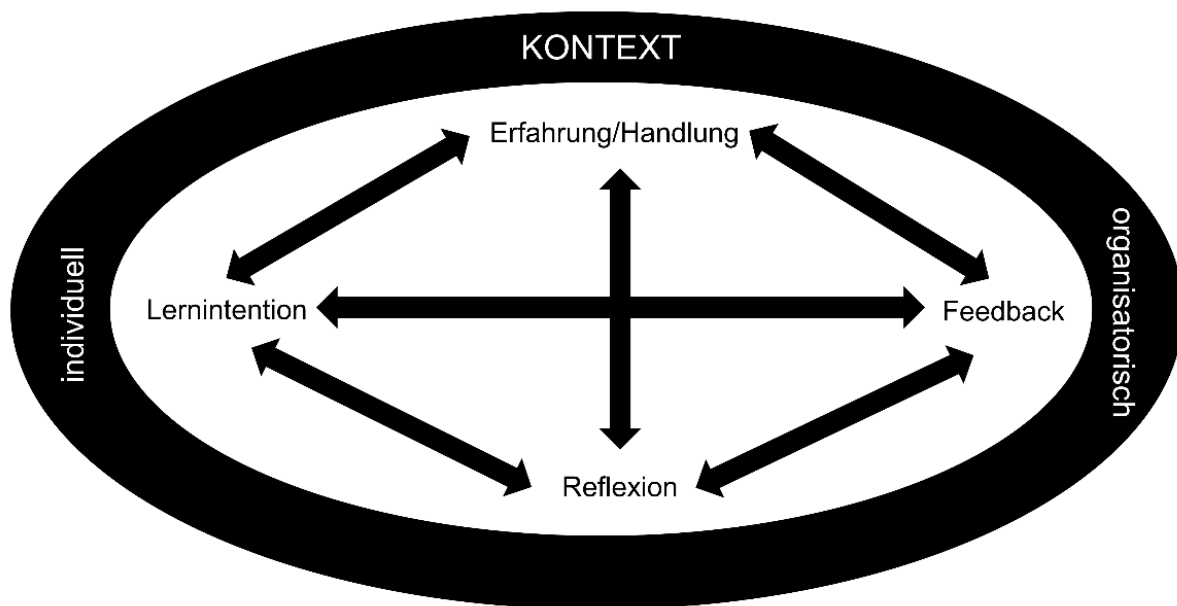
Figure 2: Dynamic model of informal learning (adapted from Tannenbaum, Beard, McNall & Salas, 2010, p. 307).

The four components are connected to each other with double arrows, which illustrate the *dynamic* character of the model: Each component can serve as a trigger for any other component and thus precede it, or it can follow another component. There is no fixed starting point in the model; the learner can enter the informal learning process at any point in the model and go through each component once or more. The learning process is said to be most efficient when all four components are involved. In the absence of the learning intention, the learner would be less likely to reflect on his or her experience or consciously seek feedback on his or her work. If the action or experience were absent, the person would lose the opportunity to learn by trying out his or her own ideas and assumptions, to develop practical skills, and to receive direct feedback from the activity. To the extent that feedback was missing from the learning process, the person learning could misunderstand the situation, miss helpful cues, and make incorrect assumptions based on their experience. In the absence of reflection, the person would be less likely to derive and internalize learning outcomes from her experiences. She might then overlook connections between and consequences of learning content and develop incomplete understanding.

In the outer ring surrounding the four components is the context of learning. This includes the individual and organizational antecedents that can affect each component in the learning process, as well as the outcome factors of informal learning that follow from the learning (see Tannenbaum et al., 2010, p. 325). Similar to Marsick and Watkins' (1990) model of informal and incidental learning in the workplace, the author of this research is not aware of

any studies conducted to date to quantitatively empirically test the assumptions from the dynamic model of informal learning.

With regard to a more differentiated view of the model components, Tannenbaum et al. (2010) provide evidence that the components can be partially subdivided or can be considered constructs with more than one expression, for example with regard to the distinction between direct and vicarious feedback. On this basis, Decius et al. (2019) developed the octagon model of informal learning in the workplace, which is described below.

2.3.3 The Octagon Model of Informal Learning in the Workplace by Decius, Schaper, and Seifert (2019).

The Octagon Model of Informal Learning in the Workplace (Decius et al., 2019) represents an extension of the dynamic model of informal learning by Tannenbaum et al. (2010). As part of the development of the Octagon Model, the four components of the dynamic model were each divided into two subcomponents (see Figure 3), which are presented below[16] .

The component "learning intention" from the dynamic model was subdivided into the subcomponents intrinsic and extrinsic learning intention in the octagon model based on the self-determination theory (Ryan & Deci, 2000). Intrinsic learning intention, however, is broader in content than intrinsic motivation in Ryan and Deci's taxonomy. The intrinsic learning intention aims primarily at the fact that the learning person learns out of interest and joy (intrinsic motivation) - since this motive occurs only rarely in the vocational practice however, the subcomponent likewise covers learning with the goal of the personal growth, which falls in the taxonomy of the self-determination theory under "integration" and is assigned thus to the extrinsic motivation[17] . Extrinsic learning intention primarily includes the "external regulation" subcomponent of the taxonomy, which describes learning for reasons of external reward (e.g., a financial reward). However, the pride of learning in order to do a better job than others also plays a role in extrinsic learning intention. In Ryan and Deci's (2000) taxonomy, this falls under the "introjection" subcomponent, which is also assigned to extrinsic motivation. As motivation research has been able to show, both intrinsic and extrinsic motivation are related to job performance - but to different degrees, depending on the measurement methodology: Intrinsic motivation is more strongly related to qualitatively operationalized performance, extrinsic motivation is more strongly related to quantitatively operationalized performance (Cerasoli, Nicklin & Ford, 2014).

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[16] The description of the model is based on the work of Decius et al, 2019, pp. 500-502.

[17] In Ryan and Deci's (2000) taxonomy, extrinsic motivation is divided into four domains: Integration, Identification, Introjection, as well as External Regulation. In addition to extrinsic motivation, the taxonomy also includes intrinsic motivation and amotivation, neither of which is further subdivided.
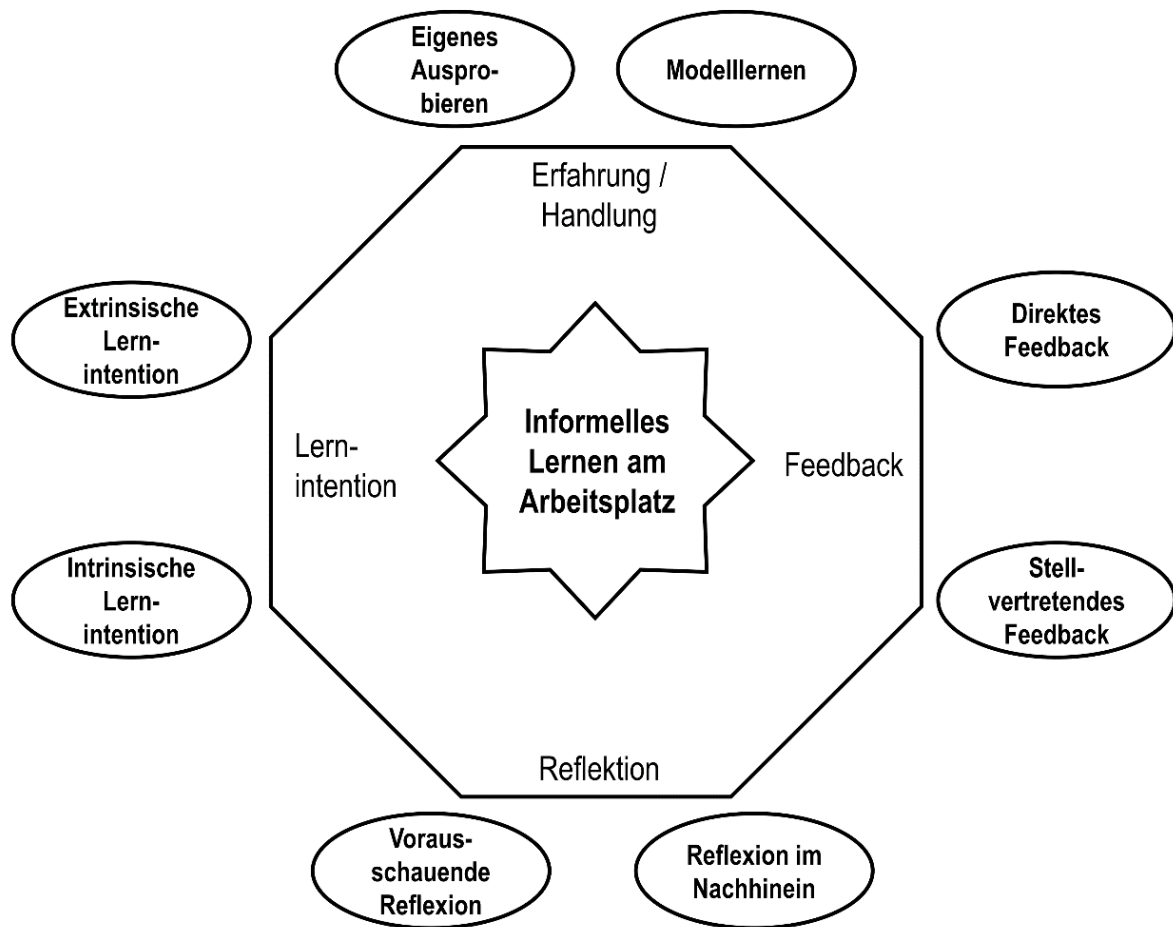
Figure 3: Octagon model of informal learning in the workplace (adapted from Decius, Schaper & Seifert, 2019, p. 502).

The component "experience and action" from the dynamic model was divided in the octagon model following the classification of Noe et al. (2013), in which a distinction is made between (1) learning from oneself, (2) learning from others, and (3) learning from non-interpersonal sources. The first two sources of learning are also mentioned earlier in Eraut (2004, p. 248) and are referred to as learning from personal experience and learning from others. Based on the findings of employee interviews during model development and in line with the findings of Eraut (2011)[18] , "learning from non-interpersonal sources" was not included in the model. "Learning from oneself" is represented in the Octagon model by the subcomponent "trying things out for oneself," comparable to the solution application aspect in Watkins and Marsick's (1990) model. "Learning from others" is covered by the subcomponent "Model

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[18] Eraut (2011) presents the results of two projects with employees, on the one hand, at the beginning and, on the other hand, at mid-career in the three fields of business/accounting, engineering and health care. He states, "The use of manuals, however, seemed to be limited to a minority who benefited from learning from manuals; while the others did everything they could to avoid [using manuals]. " (translation by the author of this paper)

learning," which is related to social learning or "learning from the model" from Bandura's (1986) social cognitive theory. Other sources had also already identified learning by observing the behavior of others as a component of informal learning (e.g., Lohman, 2006). Kortsch, Schulte, and Kauffeld (2019) extended Noe et al.'s (2013) classification to include the facet "learning through new media," which refers to the use of smartphones, apps, and Internet forums for informal learning in everyday work. While these tools play an important role for higher-skilled workers, such as the craftspeople studied as a target group in Kortsch et al. (2019), this is not the case for semi-skilled and unskilled industrial workers (so far)[19]. The employees performing simple work in industry often do not even have a computer workstation or a work e-mail address; moreover, the private smartphone may not be used at the workplace - also for legal (data protection) reasons. Therefore, "learning through new media" does not play a role in the Octagon model.

The "feedback" component from the dynamic model was subdivided into the "direct feedback" and "vicarious feedback" subcomponents in the octagon model based on the evidence from Tannenbaum et al. (2010). Direct feedback refers to the learner actively seeking feedback on his or her work performance from supervisors or colleagues. Vicarious feedback refers to the learner sharing experiences with colleagues who may be more experienced, discussing success-critical behaviors, past mistakes, and lessons learned without directly relating them to the learner's work performance. Decius et al. (2019) emphasize that passive feedback, which employees receive without having actively and willingly sought it, is excluded when defining the feedback component. This is consistent with Jarvis (1987), who highlights that not every social interaction leads to learning, but that "non-learning responses" (p. 134) are also possible in social situations[20]. Therefore, in the context of feedback, intentional, active solicitation of feedback is important.

The component "reflection" from the dynamic model was subdivided into the subcomponents "anticipatory reflection" and "reflection afterwards" in the octagon model, following Schön's (1983) classic work on the "Reflective Practitioner". Schön identifies three types of reflection in the work process: reflection before performing the activity ("for action"), reflection

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[19] There are pilot projects in industry, for example, in which tablet-based tools are installed at workstations. However, in the sense of step-by-step instructions, these tend to support the execution of work, operate within a narrow framework of production parameters, regulations and other specifications, and at least partially contradict the independent and self-determined character of informal learning.

[20] Such reactions of nonlearning occur, for example, when the person persists in his or her presuppositions without seeing any reason to change his or her behavior; when he or she does not perceive the experience or situation as a learning opportunity; or, when he or she simply rejects the option to learn something (Marsick & Watkins, 1990, pp. 12-13).

while performing the activity ("in action"), and reflection after completing the activity ("on action"). In the context of informal learning, Marsick et al. (2009) also take up this idea and emphasize that reflection can take place before, during, or after the action (p. 591). While the subcomponent "anticipatory reflection" takes place before the action and includes, for example, the anticipation of obstacles in the execution of the activity and the preparation of the work steps, "reflection after the fact" refers to the internal evaluation of one's own action result by the learning person. According to Decius et al. (2019), reflection during action is not part of the octagon model, as these are already covered by the subcomponents "own trying out" as well as "model learning". These subcomponents consequently address subareas of reflection during the performance of the activity, without which learning during and through the work task would not be possible.

The subcomponents of the "experience and action" and "feedback" components can be considered behavioral components of informal learning, since both areas involve active behavior on the part of the person learning. The subcomponents of the "reflection" component are cognitive components of informal learning, while the subcomponents of the "learning intention" component are motivational components. Thus, as a holistic conceptualization of informal learning in the workplace, the Octagon Model encompasses all relevant domains that are consistently mentioned in diverse definitions (e.g., Lohman, 2005; Mulder, 2013; Noe et al., 2013; Tannenbaum et al., 2010). Therefore, the Octagon Model serves as a reference model of informal learning throughout this paper to delineate other forms of learning from informal learning based on the content components. Why such a delimitation is necessary will be explained in chapter 3. Furthermore, the Octagon Model provides the conceptual basis for the scale used to operationalize informal learning in the workplace (Decius et al., 2019), the development of which is described in more detail in Chapter 4.1. In the past, scales have been presented by other researchers to make informal learning measurable. However, many of these approaches have weaknesses, especially with regard to the theoretical foundation of the measurement instruments. The following subchapter provides an overview of the instruments available in research and their characteristics.

2.4 Operationalizations of informal learning

In the past, more or less valid attempts have been made in research to operationalize the construct *Informal Learning*, which is considered difficult to capture, in the context of workplace learning by developing questionnaire scales. In order to obtain an overview of the measurement instruments widely used in the literature, an extensive literature search was

conducted, the results of which can be found in Table 9. Listed are questionnaire scales that relate to informal workplace learning or individual components of this construct[21].

In summary, the authors of the majority of the measurement instruments presented assume that informal learning is a multidimensional construct. Therefore, many of the instruments include multiple subscales. The majority of the approaches focus on the behavioral components of learning (e.g., trying things out on one's own or interacting with others). Sometimes cognitive components (e.g., reflection) also play a role, and less often motivational components (e.g., intrinsic learning intention). Other instruments focus, for example, on learning outcomes (Kyndt, Govaerts, Verbeek & Dochy, 2014) or the learning potential of the workplace for informal learning (Nikolova, Van Ruysseveldt, De Witte & Syroit, 2014). Some of the older procedures are only incompletely documented regarding the development history and the (qualitative) piloting of the instrument; in some cases, no information on validation can be found. Most of the newer procedures at least check the structure of the adopted subscales by means of a confirmatory factor analysis (CFA); in some cases, indications of convergent and discriminant validity as well as criterion validity are also given.

In some cases, the procedures were developed for specific target groups, which can also be seen in the respective item formulations (e.g. Berings, Poell, Simons & Van Veldhoven, 2007; cf. sample items in the notes to table 9). Some instruments have been validated with professionals from different industries and thus claim to be applicable across target groups (e.g., Grosemans, Smet, Houben, De Cuyper & Kyndt, 2020). However, this desire, which is understandable from a scientific and practical perspective, contradicts, at least in part, previous findings that informal learning processes are highly dependent on the respective target group and the associated learning context (Ellinger, 2005; Manuti, Pastore, Scardigno, Giancaspro & Morciano, 2015). Although generalized test procedures are generally to be welcomed, they always require piloting and also content validation with representatives of the respective target group in which the scale is to be used.

It is also striking that the instruments considered, listed in Table 9, are not based on conceptual models or theories, but often used qualitative case studies, interview results, schemes widely used in practice, and general literature research to determine the scale structure. An exception is the measurement instrument by Decius et al. (2019; see chapter 4.1), which is presented in detail in the context of this research and is based on the octagon model of informal learning in the workplace (see chapter 2.3.3). Following the overview of possible operationalizations of informal learning in the workplace now presented, the following

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[21] For other workplace learning measurement instruments that include formal and informal learning components mixed together without original informal learning subscales, see Kyndt and Baert (2013, pp. 280, 283) for an overview.

subchapter is dedicated to the accompanying constructs associated with informal learning: the antecedents and outcomes of informal learning.

Table 9: Structure, characteristics, notes on validation and theoretical foundation of questionnaire-based measurement instruments for operationalizing informal learning in the workplace.

Authors	Year	Items	Subscales	Type of informal learning	Reliability	Validation	Samples	Theoretical foundation of the instrument structure
Kirby, Knapper, Evans, Carty & Gadula	2003	10 items	Deep Scale subscale (one of three subscales that together make up the Approaches to Learning at Work Questionnaire" form)	Behavior, motivation, and attitudes toward learning	α = .72 (first half of total sample); .71 (second half).	Structural testing by means of CFA	Study 1: 305 Canadian university alumni; Study 2: 167 financial sector employees.	None; exploratory approach, building on Knapper's (1995) scale.
Lohman	2005	Frequency query for 9 learning activities (including one open category "other activities".	No subscales available	Behavior	α = .63	Content validation only with two expert interviews and piloting in the field with nine people.	318 Public school teachers and staff development workers (U.S.)	None; based on qualitative studies from previous literature.
Berings, Poell, Simons & Van Veldhoven	2007	29 items in 10 subscales on 2 factors (5 subscales per factor)	1. learning through... work experience (3 items); bringing in new things (3); seeking information (3); information sessions/coaching (5); self-reflection (5); 2. learning through talking about... nursing expertise (2); putting things in perspective (2); organizing patient care (2); gathering information (2); being proactive (2).	Behavior, cognitions	1st factor: α = .79; .79; .80; .87; .81; 2nd factor: α = .67; .77; .83; .85; .80	Evidence for convergent, divergent, and criterion validity.	372 Dutch nurses	None; based on interviews using the situation-response design (Endler & Hunt 1966) with 45 individuals from the nursing profession.
Authors	**Year**	**Items**	**Subscales**	**Type of informal learning**	**Reliability**	**Validation**	**Sample**	**Theoretical foundation of the instrument structure**

Authors	Year	Items	Subscales	Type of informal learning	Reliability	Validation	Sample	Theoretical foundation of the instrument structure
Mountain & Chyung	2008	Frequency query for 8 learning activities	No subscales available	Behavior	Not specified	Not specified	125 working users of a listserv (mainly from the personnel sector)	None; adapted version from Lohman (2005).
Choi & Jacobs	2011	12 items in 3 subscales (number equally distributed)	Learning with others; Own experimentation; External scanning	Behavior	α = .69; .76; .68	Evidence of convergent validity; structural testing using CFA.	203 Korean bank managers	None; adapted version from Lohman (2005).
Noe, Tews & Marand	2013	9 items in 3 factors (equally distributed)	Learning from self; learning from others; learning from non-interpersonal sources.	Behavior	α = .71 (no α-values given for the subscales).	Piloting with one executive, quantitative content validation with 47 business students; structural testing using CFA.	180 restaurant managers from the U.S. themed restaurant industry.	None; building on previous literature
Bernadette Van Rijn, Yang & Sanders	2013	11 items in 3 subscales	Staying current (4 items); obtaining feedback from supervisors (2); sharing knowledge (5).	Behavior	α = .75; .81; .85	Structural testing by means of CFA	323 teachers from Dutch vocational training institutions	None; use of a scale from Geijsel, Sleegers, Stoel & Krüger (2009) for "Staying informed" and adapted scales from Van Woerkom (2003) for "Getting feedback from supervisors" and "Sharing knowledge"
Kyndt, Govaerts, Verbeek & Dochy	2014	19 items in 3 subscales	Generic (10 items), job-specific (5), organization-specific (4) learning outcomes.	Learning Outcomes	α = .88; .79; .78	Piloted with a socio-educational specialist and a language specialist; evidence of convergent and discriminant validity; structural testing using CFA.	1186 Flemish socio-educational employees	None; based on the literature and a classification scheme from practice ("Flemish competence profile of the Forum on Education in Socio-Educational Care Work").
Nikolova, Van Ruysseveldt, De Witte & Syroit	2014	12 items in 4 subscales (equally distributed)	Learning through reflection; learning through experimentation; learning from colleagues; learning from supervisors.	Learning potential of the workplace	α = .91; .90; .83; .90	Evidence for convergent, divergent, and construct validity; structural testing using CFA.	1013 Dutch professionals from various industries	None; not described in more detail following three taxonomies from the literature, whose correspondence with the scale is only evident to a very limited extent

Authors	Year	Items	Subscales	Type of informal learning	Reliability	Validation	Sample	Theoretical foundation of the instrument structure
Froehlich, Beausaert & Segers	2017 *	12 items in 4 subscales	Obtain feedback from supervisors (3 items); obtain feedback from colleagues (3); seek help (2); obtain information (4)	Social learning behavior	α (total sample) = .86; .83; .66; .69	Piloting through feedback from experts (not described in detail); structural testing using CFA.	Total sample = 780, divided into four subsamples: 115 Dutch ambulance service employees; 613 Dutch university employees; 77 employees of an Austrian IT company; 90 employees of an Austrian chamber of commerce.	None; based on the behavioral items from the scale on learning conditions for non-formal and informal learning (Kyndt, Dochy & Nijs, 2009).
Wolfson, Tannenbaum, Mathieu & Maynard	2018	9 items in 3 subscales (equally distributed)	Feedback/reflection-based learning; vicarious learning; learning through experimentation/new experiences.	Behavior, cognitions	Sample 1: α = .75; .72; .74; Sample 2: α = .84; .83; .81; Sample 3: α = .84; .81; .81	Quantitative piloting with 32 academic and student participants; evidence of convergent validity; structural testing using CFA.	Sample 1: 400 individuals, obtained for a fee via Amazon Mechanical Turk (MTurk); Sample 2: 1707 U.S. hospital workers; Sample 3: 407 U.S. hospital workers.	None; item development based on definitions from the literature.
Kortsch, Schulte & Kauffeld	2019	12 items in 4 subscales (equally distributed)	3 Factors from Noe et al. (2013), supplemented by learning through the use of new media.	Behavior	Study 1: α = .65; .65; .75; .74; Study 2: α = .51; .61; .66; .61	Piloting with representatives of the Chamber of Crafts; structural review by means of CFA	Study 1: 131 German professionals from various industries; Study 2: 483 employees from German small and medium-sized craft enterprises.	None; based on the scale of Noe et al., (2013); extension is based on (unspecified) qualitative case studies in the skilled trades.
Decius, Schaper & Seifert	2019	24 items in 8 subscales (equally distributed)	Own trial and error; Model learning; Direct feedback; Vicarious feedback; Anticipatory reflection; Reflection after the fact; Extrinsic learning intention; Intrinsic learning intention.	Behavior, cognitions, motivation, and attitudes toward learning.	α = .82 (sample 1)/.88 (sample 2).; .77/.80; .82/.83; .86/.91; .76/.76; .82/.82; .76/.77; .88/.92	Piloted using "thinking aloud" interviews (Flaherty, 1975; Willis, 2005) with 15 industry workers; evidence of convergent, discriminant, and criterion validity; structural testing using CFA.	2 samples: 546 and 349 industrial employees from German SMEs	Theoretically based; based on the Octagon Model, which is an extension of the model of Tannenbaum, Beard, McNall & Salas (2010); item development based on twelve interviews with managers in German SMEs.
Authors	**Year**	**Items**	**Subscales**	**Type of informal learning**	**Reliability**	**Validation**	**Sample**	**Theoretical foundation of the instrument structure**
Grosemans, Smet,	2020	13 items in 3 subscales, 2 of which address	Informal learning from personal sources (6 items); Informal learning from environmental	Behavior	α = .89; .81; .83	Piloted by employee interviews (N = 20); evidence of convergent, discriminant, and predictive validity, group-based measurement invariance; structural testing using CFA.	3232 Flemish professionals from various industries	None; deductive approach based on definitions and items from previous measurement instruments.

| Houben, De Cuyper & Kyndt | informal learning. | sources (3); Formal learning (4). |

Notes: CFA = confirmatory factor analysis; SME = small and medium-sized enterprise.

* The scale of Froehlich, Beausaert & Segers (2017) was first presented in a previous research paper, but only with the mention of example items for each subscale (see Froehlich, Beausaert, Segers & Gerken, 2014).

Noe, Tews, and Marand (2013) state that the three subscales of their instrument are so highly correlated that the author team decided to use a single-factor solution - despite a good model fit of the three-factor solution. Therefore, they only give an overall value for internal consistency (Cronbach's alpha).

Sample items for the scales or subscales mentioned:

- Noe, Tews & Marand (2013): "Reflecting about how to improve my performance" (factor *Learning from oneself*); "Interacting with a mentor" (factor *Learning from others*); "Reading professional magazines and vendor publications" (factor *Learning from non-interpersonal sources*).

- Kortsch, Schulte & Kauffeld (2019): "I applied new utilities (e.g. smartphone, app)." (*Learning from new media* subscale). The other subscales are identical to Noe et al. (2013).

- Kyndt, Govaerts, Verbeek & Dochy (2014): "Through my daily practice, I have learned ... to reflect critically and constructively about my own professional conduct." (Subfactor *Generic learning outcomes*); "... to build up and maintain a counselling relationship with clients offering the requested assistance and services." (*Job-specific learning outcomes* subfactor); "... to participate in policy development and policy implementation." (*Organizational-level learning outcomes* subfactor).

- Nikolova, Van Ruysseveldt, De Witte & Syroit (2014): "In my work I am given the opportunity to contemplate about different work methods." (subscale *Learning through reflection*); "In my job I can try different work methods even if that does not deliver any useful results." (subscale *Learning through experimentation*); "My colleagues tell me if I make mistakes in my work." (subscale *Learning from colleagues*); "My supervisor helps me see my mistakes as a learning experience." (subscale *Learning from supervisor*).

- Froehlich, Beausaert & Segers, 2017: "Feedback from my supervisor makes me reflect." (Feedback-seeking *from the supervisor* subscale); "Feedback from colleagues motivates me to act." (Feedback-seeking *from the colleagues* subscale); "Getting help would be one of the first things I would do if I were having trouble at work." (*Help-seeking* subscale); "I participate in project groups to discuss work-related problems." (*Information-seeking* subscale).

- Kirby, Knapper, Evans, Carty & Gadula (2003): "In trying to understand new ideas, I often try to relate them to real life situations to which they might apply."

- Bernadette Van Rijn, Yang & Sanders (2013): "I read professional literature." (subscale *Keeping up-to-date*); "When I think that I haven't done a good job, I talk about it with my supervisor." (subscale *Asking for feedback from supervisors*); "I share my knowledge and experiences with my team members on a regular basis." (*Knowledge sharing* subscale).

- Wolfson, Tannenbaum, Mathieu & Maynard (2018): "Seeking and receiving coaching or advice from job experts" (*Feedback/Reflection-based learning* subscale); "Intentionally observing someone do his or her job" (*Vicarious learning* subscale); "Performing a task in a new and different way" (*Learning through experimentation/New experiences* subscale).

- Berings, Poell, Simons & Van Veldhoven (2007): "In the last two years I have ..." **Factor 1:** "... developed myself in the support of patients and family by experiencing relevant job situations." (subscale Work experience); "... developed myself in taking initiatives at work by adopting new tasks in which this can be developed." (subscale Adding something new); "... developed myself in the support of patients and family by searching for information in books, journals, TV, or the Internet." (subscale Searching for information); "... developed myself in planning the care of my patients by attending informative meetings or a coaching program." (subscale Information meetings/coaching); "... improved my technical nursing skills by reflecting about this by myself." (subscale Reflecting by oneself). **Factor 2:** "... improved my technical nursing skills by asking my colleagues informative questions." (Technical nursing skills subscale); "... developed myself in putting emotionally difficult situations into perspective by asking my colleagues informative questions." (subscale Putting things into perspective); "... developed myself in planning the care of my patients by asking my colleagues informative questions." (subscale Organizing patient care); "... learned more about where I can find reliable information sources by reflecting about this with my colleagues." (subscale Finding information); "... developed myself in taking initiatives at work by asking my colleagues informative questions." (subscale Taking initiatives).

- Lohman (2005): "How frequently do you use the following activities when you need to learn something new at work? ... Reflect on your actions".

- Decius, Schaper & Seifert (2019): see chapter 4.1.3

- Berg & Chyung (2008): "How frequently do you engage in the following activities, when you have to learn something new to perform your job tasks? ... Learn from my own trial and error".

- Choi & Jacobs (2011): "I collaborate with others who shared the need to solve a particular problem." (subscale *Learning with others*); "I spend time to reflect on how I dealt with a challenging work situation." (*Self-experimentation* subscale); "I attend nonmandatory professional conferences or seminars that might provide useful information." (*External scanning* subscale).

- Grosemans, Smet, Houben, De Cuyper & Kyndt (2020): "Asked others for information." (subscale *Informal learning activities using personal sources*); "Read magazines, websites, books, etc." (subscale *Informal learning activities using environmental sources*); "Took part in a workshop." (subscale *Formal learning activities*).

2.5 Antecedents and outcomes of informal learning.

As with other constructs, science regarding informal learning is interested in considering learning in the context of other variables. Informal learning does not occur in a "vacuum" but is related to antecedents (preceding variables) on the one hand and learning outcomes on the other. In the following, an overview of the constructs associated with informal learning is provided; four models and classifications are presented and compared in terms of content and structure. First, the conceptual framework model of Tannenbaum et al. (2010) is considered, which accompanies the dynamic model of informal learning of this author team already presented in chapter 2.3.2. Subsequently, the "learning at work" framework model of Baert (2018) is considered, which focuses on informal learning. In addition, the classification scheme from the literature review by Kyndt and Baert (2013) is presented. Finally, the framework model of antecedents and learning outcomes of informal learning from the meta analysis of Cerasoli et al. (2018) is presented.

Tannenbaum et al. (2010) established their framework model to name and structure future research fields and topics in the context of informal learning. At its core, the framework model consists of the four components of the dynamic model of informal learning and extends it to include antecedents and learning outcomes. In doing so, Tannenbaum et al. (2010) subdivide the antecedents into organizational/situational characteristics and individual characteristics. Organizational/situational characteristics include the following aspects, which mainly relate to working conditions as well as interactions with others in the workplace: (1) Organizational Climate; (2) Learning Opportunities; (3) Time; (4) Support/Facilitation; (5) Tools and Processes; (6) Strategic Perspective. Individual characteristics include the following person related constructs: (1) Motivation to learn; (2) Personality traits; (3) (Reflective) self-awareness; (4) Feedback orientation; (5) Self-efficacy. Learning outcomes, on the other hand, are divided into organizational and individual outcomes. Here, the learning outcomes relevant to the organization include the following aspects: (1) readiness/competencies; (2) employee retention; (3) learning culture; (4) agility. Finally, the learning outcomes at the individual learner level include these constructs: (1) education; (2) performance; (3) commitment; (4) motivation; (5) self-efficacy; (6) adaptability.

While the learning outcomes of Tannenbaum et al. (2010) are only presented with the above-mentioned keywords, the team of authors goes into more detail on the individual antecedents and presents an overview of the empirical findings to date for each factor: All variables are more or less strongly related to informal learning or related constructs. Apart from this foundation in the derivation of the antecedents, the author of this research has no knowledge that the framework model in its entirety has been empirically tested in subsequent studies.

The approach of Baert (2018) shows parallels to the framework model of Tannenbaum et al. (2010). In developing his conceptual model, Baert refers to his own preliminary work from practical projects as well as to the classifications of Sambrook (2005) and Eraut (2004), in each of which context factors and learning factors are distinguished. Baert (2018) describes his model as a "context-input-process-output basic model" (p. 165) in order to cover the entire chain of effects in relation to informal learning through this structure. Baert divides the antecedents into three areas, which in turn interact with each other: the work environment, the characteristics of the employees, and the characteristics of the work. The work environment and work characteristics are thus a more fine-grained subdivision of the organizational/situational characteristics mentioned in Tannenbaum et al. (2010). As in Tannenbaum's model, Baert's learning outcomes and learning consequences refer to the organization on the one hand and to the employees and their careers on the other.

Baert's broader concept of the work environment refers to characteristics at the organizational level, while the area of work characteristics focuses more on individually different resources and requirements of the respective workplace. According to the model, the work environment includes the following five factors, each of which is subordinated to different variables (see Baert, 2018, for more details): (1) mission and organizational strategy; (2) management style; (3) organizational structures; (4) communication systems; (5) organizational culture. Work characteristics, on the other hand, are not subdivided into further factors; the following variables are assigned to the domain: (a) Autonomy and freedom of action; (b) Task complexity and difficulty; (c) High exposure to stresses; (d) Task variety; (e) Learning potential and intensity of work; (f) Workload and job demands; (g) High level of information processing.

Employee characteristics are associated with the following variables in Baert's model: (a) willingness and motivation to learn; (b) prior learning, competencies for self-directed learning, and self-efficacy; (c) competencies regarding teamwork and team learning; (d) openness to give and receive feedback; (e) willingness to innovate; (f) tolerance for unpredictability and uncertainty; (g) length of service and number of job functions performed within the organization; (h) Amount of task experience, including critical experience; (i) Metacognitions (knowledge of one's own knowledge, of one's own actual performance, and of appropriate judgment processes); (j) Initiative; (k) Age and preference for individual or socially embedded learning; (l) Hierarchical position and learning support; (m) Outgoing or appreciative personality; (m) Domain-specific work experience. The characteristics of employees are thus subdivided in more detail in Baert (2018) than in the framework model of Tannenbaum et al. (2010), although they are not further explained beyond the keywords mentioned.

Individual learning outcomes or consequences of informal learning in the workplace include the following areas: (1) innovative work behavior; (2) job satisfaction; (3) flexibility; (4) maintaining work ability and job; (5) employability ("employability") for changing jobs during

one's career; (6) mastery of work, obtaining high-quality assessment results; (7) promotion/advancement; (8) financial rewards; (9) confidence; (10) love of and pleasure in learning. While the Baert model focuses on the person-oriented perspective (e.g., own employability for a change of job or organization), the Tannenbaum model views individual learning outcomes more from an organi sational perspective (e.g., employee commitment to the organization, which Baert counts as an organizational learning outcome).

For Baert (2018), the learning outcomes or consequences of informal learning for work groups and the organization as a whole include the following areas: (1) Innovation and continuous renewal; (2) Consumer or customer satisfaction; (3) Commitment and corporate sense of purpose; (4) Employee retention; (5) Ability to strategically manage change; (6) Quality improvements; (7) Improved team and organizational sation performance; (8) Financial benefits and savings; (9) Trust; (10) Learning culture improvements.

The description of Baert's model forms the final chapter of the edited work "Informal learning at work: Triggers, antecedents, and consequences" by Messmann, Segers, and Dochy (2018). The individual chapters present diverse empirical studies by various authors on antecedents and outcomes or consequences of informal learning. Baert (2018) draws on these studies in developing his framework model and refers to the underlying empirical chapters of the edited work for each of the model components. He also incorporates other empirical findings from the literature on informal learning. As with the framework model of Tannenbaum et al. (2010), however, the author of the present research is not aware of any empirical verification of Baert's overall model in subsequent studies.

Kyndt and Baert (2013) also take an empirical approach: In their literature review based on 56 individual studies, they present a large number of antecedents of workplace learning[22]. Their classification scheme of antecedents distinguishes between the micro-level, the meso-level, and the macro-level with regard to the individual or organizational degree of the antecedents. In doing so, Kyndt and Baert refer to the conceptual approach of Baert, De Rick, and Van Valckenborgh (2006), which distinguishes influencing factors at the level of the learning person, at the level of the learning or training activity, and at the level of the social context and the actors involved. As a result of an analysis of the primary studies included in the literature review, Kyndt and Baert assign the antecedents to the micro, meso, or macro level, respectively. They inductively divide the levels into different domains.

The micro-level includes the following three domains: (1) sociodemographic characteristics (e.g., age, gender); (2) personal characteristics (e.g., conscientiousness, self-efficacy); (3)

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[22] Kyndt and Baert (2013) use the term workplace learning to refer to both formal and informal learning in the workplace. While the overview of antecedents (pp. 281- 282) refers to both forms of learning, the text of the literature review distinguishes in each case the extent to which empirical evidence of antecedents applies to both or only one form of learning.

work characteristics (e.g., income, job demands). The meso-level includes only the learning activity domain (e.g., learning support, expected benefits). The macro level includes the following domains: (1) Organization (e.g., company size, procedural fairness); (2) Wider context (likelihood of job loss, out-of-work support).

The classification scheme of Kyndt and Baert (2013) is based in particular on empirical studies from the literature on informal and work-based learning. Since it is an overview of the antecedents and not a process-oriented model, no structural hypotheses can be derived that could be empirically tested - apart from the connections between the antecedents and learning underlying the literature review.

Going one step further in terms of summarizing the empirical evidence from the previous literature, Cerasoli et al. (2018) conducted their meta-analysis based on 49 studies with a total of 55,514 participants. Regarding personal antecedents, they distinguish individual predispositions and demographic variables. As part of the individual predispositions, the factors "personality/willingness" (ϱ^{23} = .27) and "learning-related motives" (ϱ =. 33) show medium significant, positive correlations[24] with informal learning. Among demographic variables, significant associations of mostly small magnitude emerge for age (ϱ = -.07, i.e., younger individuals learn slightly more informally), education level (ϱ = .10, i.e., better educated individuals learn more informally), gender (ϱ = -.03, i.e., women [coded 0] learn minimally more informally than men [coded 1]), income (ϱ = -.05, i.e., lower-income individuals learn slightly more informally), length of service (ϱ = .18, i.e., individuals staying longer at work learn more informally), and marriage status (ϱ = .17, i.e., married individuals [coded 1] learn more informally than single individuals [coded 0]). The association with experience level is not significant (ϱ = .01). In particular, however, the associations of informal learning with age, gender, and income are negligible in practice because of the small effect size. All personal factors taken together[25] show only a low association with informal learning (ϱ = .04). This is due to the overall low joint effect of the demographic variables (ϱ = .02), which is not significant, while the individual predispositions are jointly related to informal learning at a medium level (ϱ = .27).

With regard to situational antecedents, Cerasoli et al. (2018) distinguish between the three areas of work/task characteristics, support, and learning opportunities. In the area of "work/task characteristics," the factors "control/autonomy" (ϱ = .31) as well as "resources" (ϱ =

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[23] In the meta-analysis of Cerasoli et al. (2018), ϱ is the correlation between antecedents or learning outcomes and informal learning corrected for the total population.

[24] The basis of significance testing in the meta-analysis is a 95% confidence interval.

[25] The differences between the individual values of the correlations and the weighted correlation values considered together result from the fact that the respective characteristics are contained in a different number of primary studies (for example, the correlation for "age" is based on 15 studies, while for "experience" it is only four studies).

.30) correlate most strongly with informal learning; the correlation with "work demands" (ϱ = .13) is significantly lower. In the "support" domain, all three factors show medium correlations with informal learning: formal organizational support (ϱ = .38), informal organizational support (ϱ = .30), support from other people (i.e., colleagues and supervisors; ϱ = .31). The "Learning Opportunities" domain includes two factors that correlate only slightly with informal learning, namely "Potential for New Learning" (ϱ = .12) and "Time Available" (ϱ = .14). In contrast, the factor "Lower workload" yields no significant correlation with informal learning (ϱ = -.02). All situational factors taken together show a low to moderate correlation with informal learning (ϱ = .22). "Support" is the most strongly correlated (ϱ = .32), followed by "work/task characteristics" (ϱ = .21), while "learning opportunities" show no significant relationship with informal learning (ϱ = .04).

With regard to learning outcomes, Cerasoli et al. (2018) differentiate the three aspects attitudes, acquisition of knowledge/skills, and performance. While the factor "attitudes" shows a correlation with informal learning in the low to medium range (ϱ = .29), the correlation is significantly stronger for "acquisition of knowledge/skills" (ϱ = .41) and "performance" (ϱ = .42). All three factors taken together show a correlation with informal learning in the medium range (ϱ = .33).

In the overall view of the meta-analysis of the team of authors around Cerasoli, it can be stated that the situational variables show a higher correlation with informal learning compared to the personal variables. The demographic aspects are responsible for the low correlation of the personal variables with informal learning, while the individual predispositions show correlations in the medium range. The correlations of informal learning with learning outcomes are the most pronounced. Since the meta-analysis is a correlational research design, no conclusions can be drawn about the causal mechanisms of action between the constructs presented. Thus, the classification of the variables as antecedents or outcomes of informal learning is made solely on a theoretically argued basis. The author of this research is not aware of a longitudinal review of the metaanalytically presented correlations in their entirety; however, the second manuscript of this thesis deals with the cross-sectional, simultaneous modeling of the most relevant correlations for industrial employees in SMEs of the framework model of Cerasoli et al. (2018) in a structural equation model (Decius, Schaper & Seifert, 2020[a] ; cf. chapter 4.2).

In summary, with regard to the models and classification schemes on antecedents and outcomes of informal learning by Tannenbaum et al. (2010), Baert (2018), Kyndt and Baert (2013), and Cerasoli et al. (2018), it can be said that - despite different levels of granularity of the considered constructs - they predominantly show structural similarities[26] . In particular,

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[26] In Kyndt and Baert (2013), however, only antecedents, not learning outcomes, are considered.

the ubiquitous division between individual/personal and organizational factors stands out. The selection of the various variables considered, on the other hand, differs greatly between the approaches mentioned. For the most part, all models can be regarded as theoretically and empirically well-founded - however, it must be noted with reservation that no empirical testing of the implied relationships in their entirety is known to date.

Since the approaches considered are basically generic and do not explicitly address informal learning of production employees in SMEs, a novel approach for this target group is developed with the APO framework model of antecedents, processes and learning outcomes of informal learning at work in sub-study 2 of this research (see chapter 4.2). Here, as mentioned above, the framework model of Cerasoli et al. (2018) is used as it has the strongest empirical evidence.

After the topics of definitions, conceptualizations or modeling, operationalizations of informal learning as well as related antecedents and learning outcomes have been explained in chapter 2, the following chapter is dedicated to the differentiation of informal learning from related concepts in work-related educational research as well as industrial and organizational psychology.

3. Differentiation of informal learning from other forms of learning

In order to be able to define and describe a scientific construct, it is necessary to also illuminate the peripheral areas of the construct and the transitions to related constructs. This way, the discriminatory power of the construct can be evaluated as well as any overlaps with other constructs can be made visible - and it can be highlighted what the construct in question is *not* (Kraiger, 2017)[27]. Therefore, informal learning will be differentiated from other forms of learning in terms of structure and content in the context of this research (Chapter 3.3). In order to achieve this goal, the following sections first explain the term "learning form" in more detail (Chapter 3.1) and describe seven structural dimensions to characterize learning forms (Chapter 3.2). The definition of a "form of learning" is related to learning in the context of work; thus, learning forms of work-related learning are considered. Thus, it is *not* the aim of the present research work to establish a context-independent and generally valid definition of the term "learning form".

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[27] Kraiger (2017) notes in his book chapter on the construct validity of autonomous learning, "As in all fundamental construct validity work, it is important to not only define (through words and with data) what the construct is, but also what it is not" (p. 311).

Besides the definition of a scientific construct, the structural classification of the construct in a superordinate context is also desirable. Therefore, it is described below how informal learning can be classified as part of the superordinate context of work-based learning (chapter 3.4). To get a complete picture of this classification, the other forms of learning considered here are also located as parts of work-related learning. This excursus makes it possible to grasp the diversity of work-related forms of learning as well as to classify the theoretical significance of informal learning and - despite its high practical relevance - not to overestimate it: Informal learning is to be considered as an important, but just as *one of* several forms of learning. From a theoretical perspective, these forms of learning can be distinguished from one another, but in practice they are often intertwined and interwoven (cf. chapter 3.4).

3.1 Definition of the terms "learning process", "learning outcome" and "learning form

The term "learning form" is often used inconsistently in corporate education research, sometimes understood as synonymous with learning methods and often not defined at all (Molzberger, 2008; Schmidt, 2006; Schüßler, 2004). Sometimes, the triad of the terms "informal learning", "non-formal learning" as well as "formal learning" is also referred to as "forms of learning" (e.g. Bilger, 2016; Kirchhöfer, 2004) - however, this view falls short and excludes various recognized and widely used learning concepts in the literature. Other authors, on the other hand, try to avoid defining forms of learning by focusing on context and advocating the use of terms such as "learning processes in an informal context" (e.g., Düx & Sass, 2005; see Kahnwald, 2018, pp. 343-344, for an overview). In the following, the understanding of "learning form" underlying this work will be explained. For this purpose, it is first necessary to define the terms "learning process" and "learning outcome", as these form the basis for the term "learning form".

3.1.1 Learning process

A learning process is a mental process by which relatively permanent changes in behavior or behavioral potential (thinking, feeling) occur as a result of (or as a result of) previous experiences (Gross, 2010, p. 160; see also Kraiger & Ford, 2020, p. 3). It is an adaptive process in which behavioral changes occur as a result of interactions with the environment (Carlson, 1990, p. 99). Learning processes can be categorized into three groups (Bourne & Ekstrand, 2005, p. 132): (1) Classical conditioning; (2) Instrumental or operant conditioning; (3) Cognitive (and observational) learning. In the context of corporate education research, cognitive learning is almost exclusively relevant. Typical for a cognitive learning process are the following iterative components (cf. Bourne & Ekstrand, 2005, pp. 173-175; Renkl, 2015, pp. 6-11): trigger, intake of

information and sensory impressions, cognitive processing of this information and sensory impressions as an internal construction process. A completed cognitive learning process results in a *learning outcome* (cf. Carlson, 1990, p. 99). The iterative components of the cognitive learning process mentioned are explained in more detail below:

1. <u>Trigger</u>

For example, the trigger of a cognitive learning process can be an external stimulus (e.g., set by a teacher or a curriculum) or an internal stimulus that signals dissatisfaction with the current way of acting or thinking (Segers et al., 2018). This dissatisfaction can be conceptualized as a disturbance ("disturbance") within Jean Piaget's theory of equilibration of cognitive structures[28] (cf. Hirschmann & Mulder, 2018). Piaget (1977) views such disturbances-such as unexpected action outcomes, gaps in knowledge, or errors that occur-as triggers of a developmental process whose goal is to eliminate the disturbance and restore a state of equilibrium. This view is consistent with Festinger's (1957) theory of cognitive dissonance, which states that conflicting actions, beliefs, ideas, or values trigger an unpleasant cognitive state that the affected person wants to eliminate as soon as possible, e.g., by applying attribution strategies. According to Baert (2018), a trigger leads to disturbances ("disturbances"), which trigger a need to learn, which in turn leads to a learning intention.

A prior learning outcome can also serve as a trigger for a cognitive learning process (see section below on "Learning Outcome" in this chapter). In certain learning contexts, moreover, it is difficult to determine the nature of the trigger[29] .

2. <u>Absorption of information and sensory impressions</u>

Information intake is to be understood as a physically oriented, observable activity that can be followed by a cognitive processing process (encoding) (Bourne & Ekstrand, 2005, p. 180; Mulder, 2013). In this context, information intake behavior includes different modalities, e.g., speaking, listening, writing, reading, observing, or performing manual activities, depending on the learning situation and context as well as individual preference (Bourne & Ekstrand, 2005; p. 153; cf. Wilson, 1998). A distinction can be made whether these behaviors occur in the context of social interaction or individually (Mulder, 2013).

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[28] Piaget (1977) assumes that a person tries to assimilate new information into his previous mental frame of reference of existing thought structures. If this is not possible, a disturbance of equilibration (from Latin *aequilibrium*: "balance") occurs. In order to resolve the inner contradiction, the person adapts or expands his or her own thought structures (accommodation).

[29] In the incidental learning context, the learning process takes place unintentionally and unconsciously during an action. The trigger for this can already be the search for a place or the start of an action (cf. in detail chapter 3.3.3 on incidental learning).

Both information intake and subsequent information processing can be influenced by a variety of internal and external factors. These include, for example, the learning context or the experienced situation, motivational aspects, characteristics such as personality and intelligence of the learning person, and, last but not least, his or her epistemological beliefs[30] (Gruber & Stamouli, 2015).

3. <u>Processing of information and sensory impressions</u>

Information processing as an internal, cognitive construction process takes place largely unconsciously, but also includes consciously perceptible thought processes such as reflection on one's own experiences. Central to this is the "active mental engagement with the object of learning" (Renkl, 2015, p. 6). A distinction can be made between information processing "driven by sensory data", which is dependent on newly acquired information, and information processing "driven by knowledge", which increasingly draws on already existing memory content (Bourne & Ekstrand, 2005, p. 175). Both sources of information processing usually interact.

From a constructivist perspective[31] Fried (2003) describes the information processing process as follows: "Knowledge is not 1:1 transferable between people as in an informational sense (or simply solvable by people and transferable to others unchanged), but is individually cognitively constructed. Thus knowledge is observer and history dependent" (p. 50).

3.1.2 Learning Outcome

A learning outcome as a result of a cognitive *learning process* is an internal change in the structure and chemistry of the brain that is followed by a change in behavior (performance), provided that the situation is adequate for the behavior to occur (Carlson, 1990, p. 99). This changed behavior, thinking, or feeling manifests itself, for example, in newly acquired knowledge, skills, abilities, or other characteristics (KSAO; see, e.g., Noe et al., 2014, p. 247). The learning outcome can thus include an expansion of performance prerequisites

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[30] "Epistemological beliefs are understood as a person's assumptions about the nature of knowledge. Epistemological beliefs thus refer to subjective ideas about the objectivity, accuracy, meaningfulness, or origin of knowledge" (Gruber & Stamouli, 2015, p. 26).

[31] Put simply, constructivism assumes that the learner creates or constructs an individual and thus subjective representation of knowledge in the learning process. In constructivist learning theory, the teacher is not to be seen as a purely knowledge-providing person, but as a consultant and observer in the learning process (see, e.g., Reich, 2012, for an overview). This places constructivism in contrast to, e.g., cognitivism and behaviorism (see Anderson, 2000, pp. 383-387 for an in-depth discussion of these learning theories in terms of learning psychology; cf. also Schaper, 2007); in addition, Kolb (1984) as a representative of constructivism: "Cognitive theories of learning [...] tend to give primary emphasis to acquisition, manipulation, and recall of abstract symbols, and [...] behavioral learning theories [...] deny any role for consciousness and subjective experience in the learning process" (p. 20).

(competencies[32]). Through external testing and assessment of the behavior resulting from the learning outcome, there is the possibility of certification of what has been learned. In practice, learning processes often occur in sequential loops (see, e.g., Kolb, 1984). In this case, the learning person tests the learning outcome for functionality through application and/or reflection. A deviation of the learning outcome from an internally defined target state can then trigger a new cognitive learning process.

3.1.3 Learning form

Based on the previous definitions of a learning process and a learning outcome, the term "learning form" can now be defined in relation to work-based learning for use in this research:

"Learning form" is a term used to distinguish variants of cognitive *learning processes in* the context of vocational education research. A learning form must distinguish itself from other learning forms in at least one of the seven following dimensions (cf. in detail chapter 3.2):

- Dimensions of the learning context: structure specification, learning process responsibility, learning situation;
- Learner-internal dimensions: Awareness, intentional orientation, spontaneity of learning timing, stimulus for goal setting.

Often the learning processes of a learning form show an ideal-typical cycle of the components of the cognitive *learning process* (trigger, intake, processing) and an ideal-typical type of *learning outcome.*

In the following, the aforementioned seven dimensions[33] are presented to delineate different forms of learning.

3.2 Dimensions to characterize forms of learning

As mentioned in the definition of the term "learning form", the dimensions for characterizing learning forms can be divided into two areas. While the three dimensions of the

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[32] According to Weinert (2001), competence can be defined as "the cognitive abilities and skills available in or learnable by individuals to solve specific problems, and the associated motivational, volitional, and social dispositions and skills to use the problem solutions successfully and responsibly in variable situations" (pp. 27-28).

[33] In contrast to the seven inductively developed categories for analyzing the definitions of informal learning in chapter 3.2, the dimensions mentioned here - as described below - were deductively derived from the literature. Due to the broader coverage of learning processes with different characteristics, the dimensions are suitable to describe all forms of learning in a work-related context in a meaningful way, not only informal learning.

learning context can basically be observed from the outside, an external evaluation and assessment of the four dimensions internal to the learner is hardly possible or only possible under difficult conditions.

3.2.1   Dimensions of the learning context

1.   <u>Structure specification</u>

To distinguish between formal and informal learning, the criteria "degree of structuredness" (e.g., Kahnwald, 2013; Segers et al. , 2018) or "degree of planning" (e.g., Kyndt & Beausaert, 2017; Jacobs & Park, 2009) are often mentioned in the literature. These terms may be sufficient for distinguishing between formal and informal learning - but they are less helpful for delineating the totality of learning forms: the term "structuredness" is misleading in that most learning forms follow a structured process, even if this is not always visible to the outside world[34] . The term "planning" is likewise only conditionally suitable for the delimitation, since in many learning forms the learning person plans parts of its learning process in advance and sets itself learning goals (see e.g. self-regulated learning, chapter 3.3.4). Therefore, the term "structure specification" is used in the present work, which addresses the question whether the learning process follows external, specified structures, which lie outside of the learning person, or is independent of these.

2.   <u>Learning Process Responsibility</u>

The role of teachers in the learning process represents an important criterion in the description of learning concepts (e.g. Jacobs & Park, 2009; Livingstone, 2001; Colley, Hodkinson & Malcolm, 2003). Accordingly, the dimension "learning process responsibility" describes whether the responsibility for carrying out, controlling, and assessing a learning process lies with the learner or with a teacher or institution. It is also possible to divide the responsibility between these two parties. Similar criteria have also been used in the literature to delineate formal and informal learning. Some approaches in this area focus on the locus of control of the learning process ("locus of control"), i.e., control over when, what, how, and why learning occurs (Segers et al. , 2018, p. 7). Other approaches consider the proactivity of the learner's role in the learning process, particularly with respect to interactions with others (e.g., Kyndt & Beausaert, 2017).

In joint reference to the dimensions "structure specification" and "learning process responsibility" it can also be stated: Learning forms with a fixed specification regarding the

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[34] For example, Kolb's (1984) experiential learning follows a more or less fixed cycle (see chapter 3.3.7), but without (formal) structural specifications regarding the learning process.

structure and a learning process responsibility outside the learner can be described as externally determined or externally controlled, learning forms without such a specification and with learning process responsibility with the learner as self-determined, self-directed or autonomous (cf. Kraiger, 2017; Noe & Ellingson, 2017)[35] .

3. <u>Learning situation</u>

In the context of work-based learning, the (spatial) learning situation in which the learning process takes place - also called the learning setting - plays a crucial role. Classically, a distinction is made between learning on the job and learning off the job (Clarke, 2005; Jacobs & Park, 2009; Kyndt & Beausaert, 2017; Colley et al., 2003). On-the-job learning occurs either concurrently with the performance of the work task or during a period of work interruption. Thus, workplace learning is closely intertwined with the activity itself. If a learning process takes place outside the *workplace*, however, this does not necessarily mean that the learning person has to leave the workplace (i.e., for example, the company) for the learning process. It would be conceivable, for example, to use an in-house training room.

In this context, Dehnbostel (2007, p. 45) distinguishes between three conceptualizations to specify the place of learning:

1. The place of learning and the place of work can be identical, so that learning takes place at the workplace or in the work process (work-based learning).
2. The place of learning and the real workplace can be separate, but still have a direct spatial or work-organizational connection (work-linked learning).
3. Educational centers and vocational schools can act as learning venues, where practice and commissioned work takes place in environments that are as close as possible to the reality of work (work-based learning).

Such a fine classification can be practicable to describe filigree differences *within a* form of learning. For the delimitation of the learning forms *among each other,* the present work uses the broader distinction whether the learning process takes place directly at the workplace and thus directly related to the activity ("work-linked"), or whether the learning process takes place spatially and organizationally separated from the work process and the activity ("work-linked" and "work-oriented" combined). The dimension is referred to as "learning situation" - rather than "learning location" as in other research (cf. Livingstone, 2001) - to reflect the fact that both location and connectedness to work activity are relevant.

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[35] This does not apply to mixed forms in which the two dimensions do not go hand in hand, e.g. in the learning form deliberate practice (see chapter 3.3.5) or situated learning (see chapter 3.3.11). In these cases, we can only speak of conditionally self-directed or externally directed forms of learning.

3.2.2 Learner-internal dimensions

1. <u>Awareness</u>

Arnold (2016) points out that learning is part of the human self-concept and that "people cannot *not* learn at all" (p. 486). However, learning processes do not necessarily have to occur consciously and thus explicitly for the person learning, but can also occur unconsciously and thus implicitly (Argyris, 1999; Berg & Chyung, 2008; Eraut, 2000; Reischmann, 1995; Polanyi, 1967). According to Reber (1993, p. 5), learning is considered implicit when the acquisition of knowledge occurs independently of conscious attempts to learn and without explicit knowledge of what has been learned.

Often, learning awareness is mistakenly equated with intentionality (i.e., expression of learning intention) (see, e.g., Wolfson et al., 2018). However, learning processes may well occur accidentally and without a fixed intention, while the person learning is nevertheless aware of the learning[36] (e.g., by watching a report on the television news that contains historical facts that were previously unknown to the person; cf. Schugurensky, 2000, p. 4). Incidentally, the only form of learning that exclusively involves implicit learning processes is incidental learning (see chapter 3.3.3).

2. <u>Intentional alignment</u>

The dimension "Intentional Orientation" comprises the intention underlying the active activity during the learning process. On the one hand, this intention can be a dedicated learning intention, on the other hand, it can be an intention to solve problems in the work process (Rohs, 2007, p. 34). In the latter case, learning is to be regarded as an instrumental process, which serves to master challenges from the work task without pursuing a concrete learning goal (cf. Schaper & Sonntag, 2007, p. 618). The learning result then occurs as a "by-product" of the problem-solving action.

Kirchhöfer (2004) distinguishes in this context the three characteristics "problem independent", "problem-oriented" and "problem-bound" (p. 86), while Kahnwald (2013, p. 60) speaks of learning goals on the one hand and action goals on the other. In the pursuit of action goals, "the learners' attention is less focused on learning than on [...] situational masteries aimed at in each case with the help of learning" (Dohmen, 2001, p. 35). Kleinbeck (2010) also points to the shorter-term permanence of action goals:

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[36] The reverse combination, intentional and unintentional, does not normally occur and could at most be constructed as a theoretical scenario.

Outcome goals [action goals] are like consumer goods: once the desired action outcome has been achieved, the goal can be abandoned. Process objectives [learning objectives], on the other hand, generally have a longer-term effect. In learning, for example, they steer a long-lasting improvement process. (S. 289)

The learning process thus ends as soon as the problem that triggered the learning process is solved. In many learning processes, however, there is not only an intention to learn or an intention to act, but both intentions at the same time in varying degrees. Therefore, following Colley et al. (2003, p. 31), the dimension "intentional orientation" refers to which intention predominates in the learning process.

3. Spontaneity of the learning moment

Explicit learning processes can occur both in response to a situation or experience ("spontaneous learning" or "reactive learning") and deliberately ("deliberate learning" or "deliberative learning"[37]) (Doornbos, Bolhuis & Denessen, 2004; Eraut, 2000; Mulder, 2013).

Reactive learning takes place almost spontaneously ("near-spontaneous") and unplanned (Eraut, 2000, p. 115) - in the middle of the action, when there is little time to think (Eraut, 2004, p. 250). In the work context, this might be, for example, a problem to be solved or a content issue facing the person learning (Segers et al., 2018). Deliberate learning, on the other hand, is characterized by clear learning goals as well as planned learning activities for which a specific time budget is allocated (Eraut, 2004, p. 250). Accordingly, the expression of the dimension "spontaneity of the learning moment" is differentiated according to the characteristics "reactive (spontaneous)" and "deliberative (deliberative)".

Often, but not always, reactive learning is accompanied by an action goal, whereas deliberate learning is accompanied by a learning goal. As an exception, Eraut (2000), following Megginson (1996)[38] , points out that the learning person can also pursue an "emergent[39] strategy": The person then already has an idea of the learning goal and the potential learning

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[37] In contrast to other authors, Eraut (2004) distinguishes between the broader term "deliberative learning" and its component "deliberate learning": "*Deliberative learning* includes both 'deliberate' learning (Tough, 1971), where there is a definite learning goal and time is set aside for acquiring new knowledge, and engagement in deliberative activities such as planning and problem solving, for which there is a clear work-based goal with learning as a probable by-product" (p. 250).

[38] Megginson (1996) proclaims a four-field typology of planned and emergent learning with the dimension of "emergence" or spontaneity on the horizontal axis as well as "planning" (of the learning goal) on the vertical axis. This results in the following four learning types: (1) "Warrior" ("Warrior") with low spontaneity and high planning; (2) "Adventurer" ("Adventurer") with high spontaneity and low planning; (3) "Sleeper" ("Sleeper"), both low; (4) "Sage" ("Sage"), both high.

[39] According to Duden (n.d.[a]), "emergent" means as much as "(in a system) by interaction of several factors unexpectedly newly appearing, arising".

outcome in mind, but waits with the start of the learning process until an appropriate learning opportunity arises. Thus, there is a clear learning intention, but the learning moment is spontaneous and reactive (p. 116).

4. <u>Stimulus for target setting</u>

Regardless of the spontaneity of the learning moment as well as the intentional orientation of a learning process - i.e., whether an intention to act or an intention to learn is pursued - a distinction can be made as to the manner in which the goal of the learning process was established: internal or external (Colley, Hodkinson & Malcolm, 2002, p. 19).

On the one hand, an external stimulus can come from the work environment, e.g., changes in the scope or responsibility of one's own work, requirements to use a new technology, or problems occurring in the work process, errors, and failures of work steps (Marsick & Volpe, 1999, p. 5; cf. *action error classification* according to Algedri & Frieling, 2015, pp. 10-20). On the other hand, an external stimulus can be set by an institution, a teacher, or a given curriculum (Segers et al., 2018, p. 7).

An internal stimulus can be, for example, a person's drive to expand his or her own competencies, to reorganize professionally, or to prepare for a specific future event (Marsick & Volpe, 1999, p. 5). However, when a learning person sets his or her own learning goal based on an internal stimulus, this does not mean that he or she automatically bears the entire responsibility of the learning process. Conversely, the learning person may hold full learning process responsibility even if the goal setting is based on an external stimulus, e.g., a problem encountered in the work process.

Now that the seven dimensions for classifying forms of learning have been described, the following section presents various learning concepts[40] and analyzes whether each is an independent individual-related[41] form of learning. Subsequently, the identified forms of learning are distinguished from informal learning. On the one hand, the demarcation serves the purpose of being able to describe the content-related core and the boundaries of the construct of informal learning more clearly (cf. Kraiger, 2017). On the other hand, the delimitation results in new perspectives for future research, as the classification of learning forms in the overarching context of work-based learning not only contributes to the conceptualization of informal

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[40] The term "learning concept" is used here as a catch-all term for terms used and prevalent in learning research, some of which, but not all of which, can be assumed to meet the previously specified definition of a "learning form."

[41] Decidedly group- or organization-related learning concepts ("learning organizations") are not the focus of this work and will therefore not be included in the later differentiation of informal learning from other forms of learning.

learning, but also reveals differences and similarities of other work-based learning forms. The aim of the presentation is thus also a systematization of the work-related forms of learning in order to more closely grasp their underlying design factors and effective principles and to be able to assign the examples of application occurring in practice to the respective forms of learning more clearly than before.

3.3 Presentation of the forms of learning

The selection of learning concepts presented is based on scientific review papers on (both psychological and pedagogical) work-based education research (Dochy, Gijbels, Segers & Van den Bossche, 2011; Noe & Ellingson, 2017; Schaper, 2019; Segers et al., 2018; Wolfson et al., 2018) and a complementary literature review. The following theoretical learning concepts are explained:

- Formal learning
- Non-formal learning (non-formal learning)
- Incidental learning
- Self-regulated learning (self-regulated learning)
- Deliberate Practice
- Autonomous learning
- Experiential learning (experiential learning)
- Action-oriented learning (action learning)
- Transformational learning
- Situated learning
- Expansive learning (expansive learning)
- Work-based learning

Nine of the twelve learning concepts mentioned can clearly be traced back to one or more research works in the context of work-based learning. The majority of these works were written in the 1980s and early 1990s (Figure 4 provides an overview). In the case of formal, non-formal and work-based learning, there is no clear traceability to individual research works, since these concepts were often introduced into the literature in passing by various authors, in some cases without naming a definition, and were only conceptualized more systematically at a later date.

Not all of the twelve learning concepts fulfill the dimensional criteria of a learning form (cf. chapter 3.1.3). In the following, the terms mentioned are introduced, the underlying conceptualizations are explained, and an assessment is made as to whether the respective term is an independent form of learning or not. All forms of learning are then distinguished from the learning form of informal learning on the basis of the seven dimensions defined in chapter 3.2.

For this purpose, informal learning is also classified at this point on the basis of the afore-mentioned dimensions. The definitions of informal learning by Cerasoli et al. (2018), by Tannenbaum et al. (2010), and the implications from the Octagon Model (Decius et al., 2019), each of which was presented in chapter 2.3, serve as the basis for this work.
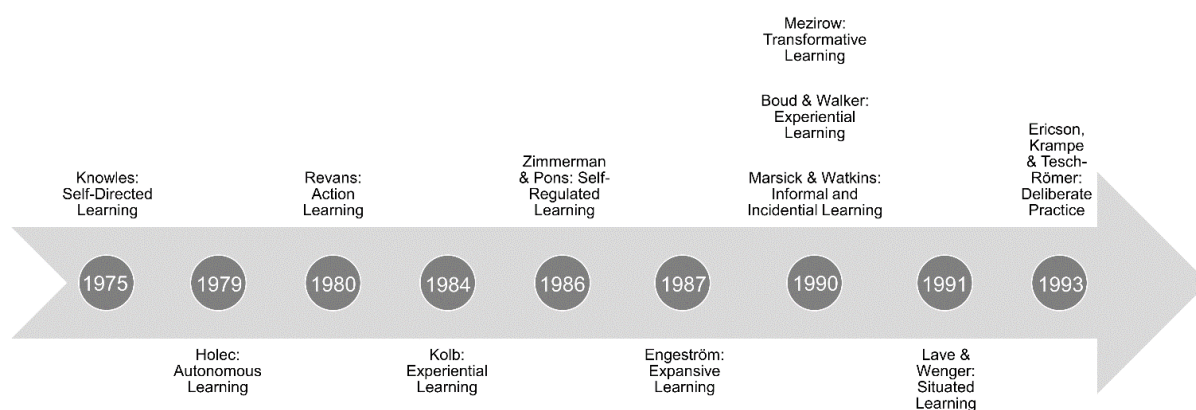

Figure 4: Chronological overview of learning concepts with clear traceability to individual research papers; own representation.

Notes: Listed in each case are the standard works with which the authors made the respective learning concept known in scientific discourse. However, some research works have their origins in earlier publications in which the respective learning concept was already rudimentarily mentioned. This is true for "Action Learning" (Revans, 1980, origin traceable to 1971), "Experiential Learning" (Kolb, 1984, origin also 1971) as well as "Transformative Learning" (Mezirow, 1990, origin traceable to 1978). Also, in the case of "Autonomous Learning," it should be noted that the first edition of Holec's work, dated 1979, is no longer available, so the second edition (Holec, 1981) is usually cited. "Self-Directed Learning," introduced by Knowles (1975), is considered a precursor to "Self-Regulated Learning" and thus has also been included in the chronological overview. "Experiential Learning" is listed twice because it was conceptualized with different focus by Kolb (1984) and by Boud and Walker (1990), and both conceptualizations are considered significant in the context of work-based learning. The concept of incidental learning existed in the literature for some time, but was first taken up and described in the context of work-based learning by Marsick and Watkins (1990).

In terms of the seven dimensions used to classify forms of learning, informal learning has the following characteristics:

- *Structure specification*: Informal learning takes place independently of external structure specifications.
- *Learning process responsibility*: The learning process responsibility in informal learning lies solely with the person learning.
- *Learning situation*: Informal learning occurs in the work situation - usually as a result of a problem or challenge in the work process - and thus directly in the workplace.

- *Awareness*: Informal learning is explicit and thus conscious to the person learning.
- *Intentional Orientation*: The learner's intention in informal learning is directed toward an action. Often, this is a problem-solving action that is necessary for the continuation of the work process.
- *Spontaneity of the moment of learning*: Informal learning occurs predominantly spontaneously in the work process and as a reaction to the demands of a situation or activity to be mastered.
- *Stimulus for goal setting*: Even though the control of the learning process lies with the person learning, the setting of the action goal in informal learning is done by an external stimulus. This stimulus can be, for example, an occurring problem or an error in the work process.

3.3.1 Formal learning

Formal learning, sometimes called formal learning, is defined as a form of learning that is highly structured in terms of learning context, learning support, learning time, and learning objectives (Kyndt & Baert, 2013). In relation to Sfard's (1998) typology of two metaphors of learning, formal learning represents a classic example of the "learning as acquisition" metaphor[42] - "systematized knowledge or skills [are] taught separately from the context of application" (Schaper & Sonntag, 2007, p. 627). In school and higher education, formal learning is the conventional and most common form of learning (Dehnbostel, 2015, p. 37). In terms of work-based learning, formal learning stands for planned and organized learning activities that are mainly funded by the employer and take place during working hours, e.g., in the context of internal or external courses (Kock & Ellström, 2011, p. 73). Characteristically, participants received a certificate or a specific assessment. Eraut (2000) also holds this view, but other authors reject it as part of a definition of formal learning (e.g., Werquin, 2008). Marsick and Watkins (1990, p. 12) also point to the institutional funding, classroom boundedness, and highly structured nature of this form of learning. Cerasoli et al. (2018) add that learning activities are planned and prescribed by a curriculum or teacher, not by the student's own curiosity (p. 204). Learning objectives, they say, are often clearly defined, and learning usually proceeds in a linear fashion with a discrete starting and ending point. Regarding the teacher, Dehnbostel

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[42] Sfard (1998) distinguishes two opposing methapers to describe learning. According to the "learning as acquisition" metaphor, there is a transfer of knowledge from an expert or other professional source with expertise to the learning person. According to the "learning as participation" metaphor, the learner acquires knowledge through participation in social and reflective activities.

(2016) emphasizes that "the learning situation is usually accompanied by professionally pre-trained persons and there is a pedagogical interaction with the learners" (p. 349).

In the work context, a common manifestation of formal learning is training and education that takes place off the job, for example, in internal or external training facilities. Organizations spend a lot of money to provide these training and education (Miller, Mandzuk, Frankel, McDonald & Bellow, 2013). In principle, these measures, if properly implemented and evaluated, are also quite effective and helpful for organizational success (Salas, Tannenbaum, Kraiger & Smith-Jentsch, 2012). However, formal training programs alone are not considered sufficient to ensure long-term organizational and employee readiness (Tannenbaum et al., 2010).

Because formal and informal learning are often contrasted, the result is sometimes a demotion of the other form of learning, depending on one's point of view (Colley et al. , 2003). Eraut (2000) also points out that there are many types of formal learning and diverse contexts for which at least some of these types are suitable, which is why he argues against formal learning acquiring a negative connotation (pp. 114-115).

In terms of the seven dimensions used to classify forms of learning, formal learning has the following characteristics:

- *Structure specification*: Formal learning largely follows external structures, often specified at the higher level by institutions, at the lower level by teachers.
- *Learning process responsibility*: The responsibility for creating the framework, implementing, monitoring and assessing formal learning lies predominantly with the institution or teacher.
- *Learning situation*: In formal learning, the learning process takes place outside the workplace, e.g. in in-house or external training rooms.
- *Awareness*: Formal learning is explicit and thus conscious to the person learning.
- *Intentional orientation*: Formal learning is intentionally oriented towards the achievement of one or more learning goals, which are usually not directly aimed at the practical solution of problems in the work process (e.g. acquisition or consolidation of basic knowledge).
- *Spontaneity of learning timing*: Formal learning is scheduled in advance and therefore takes place at a deliberate learning moment.
- *Stimulus for goal setting*: In formal learning, the learning goal is determined by an external stimulus, such as a curriculum set by institutions or teachers.

Formal learning and informal learning have very little in common. In five of the seven dimensions, they are diametrically opposed. The only exceptions are the dimensions "awareness" and "stimulus for goal setting". Both forms of learning involve explicit learning of which the person learning is aware. Furthermore, the stimulus for goal setting is external in both

cases. It should be noted, however, that the external stimulus in formal learning is usually determined by an institution or a teacher or by a prescribed curriculum, while the external stimulus in informal learning results from a requirement arising in the work process, an error or other problem.

It should also be noted that informal learning can also take place to some extent in formal contexts (for a detailed discussion of this, see chapter 3.4).

3.3.2   Non-formal learning (non-formal learning)

At the latest, when the European Commission presented its much noted tripartite division of learning forms into formal learning, non-formal[43] learning and informal learning in 2001, the concept of non-formal learning also arrived in the academic discourse (see e.g. Straka, 2004, for an overview).

In the Commission's position paper, non-formal learning is described as "learning that does not take place in educational or vocational training institutions [sic!] and does not usually lead to certification. Nevertheless, it is systematic (in terms of learning objectives, learning duration and learning materials). From the learner's perspective, it is purposeful" (p. 35). Livingstone (2001) similarly uses the term non-formal education, which occurs when learners choose to acquire further knowledge or skills by voluntarily seeking out a teacher who supports their learning interests with an organized curriculum (p. 2). Schugurensky (2000) also emphasizes the voluntary nature of non-formal learning and also notes that it is usually "short-term" learning - as opposed to long-term formal educational programs. According to Hoffman (2005), non-formal learning in the work context differs from other formal activities in that it is not funded or supported by companies.

The assessment of considering non-formal learning as a separate form of learning has not been without criticism (cf. Dohmen, 2001; Düx & Sass, 2005). Dehnbostel (2015) notes:

> *If the learning types of formal and informal learning are determined and differentiated in terms of learning theory, this does not apply to non-formal learning. This and the acquisition of competencies as a learning outcome is a rather regulatory category, which does not differ from formal learning in terms of learning theory.* (S. 39*)*

While Dehnbostel sees non-formal learning as closer to formal learning, Dohmen (2001) emphasizes the similarities with informal learning and proposes to "dispense with the subtle and sometimes controversial distinctions between 'non-formal' and 'informal' learning and to agree on an undifferentiated summary under the common term of 'informal learning'" (p. 25).

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[43] Terms used synonymously in the literature are non-formal learning and non-formal learning.

Eraut (2000) has a contrary opinion: He criticizes the widespread use of the term informal learning as a residual category to describe all learning outside formal educational programs. He also points out that the term "informal" is already associated in everyday language with different aspects apart from learning, so that a scientific use of the term is not appropriate. Instead, Eraut proposes the use of the term "non-formal learning" as a broad counter-term to formal learning, which he subdivides into implicit learning, reactive learning, and conscious learning. In a later publication, however, Eraut (2004) moves away from this classification and presents his three-part typology, unchanged in content, under the heading "Informal Learning" - without even mentioning the term non-formal learning in this publication. Colley et al. (2003) argue for a synonymous use of the terms "non-formal" and "informal" (p. 31).

This paper agrees with the view that so-called non-formal learning is not a form of learning in its own right, but in line with Dehnbostel (2015) (voluntary) learning in a formal context. This can also be illustrated by the example of acquiring foreign language skills[44] : A learner would acquire language skills in a non-formal way by voluntarily attending, for example, an adult education course. Depending on the level of requirements, this would differ little or not at all from a comparable university course in terms of structure, content and learning support. The only difference here would be that students attend the course as part of their "job" (studies), but the voluntary learner attends in his or her free time. Thus, the supposed difference between formal and non-formal learning is rather a social-normative demarcation, which is not of learning-theoretical nature. Therefore, no separate distinction from informal learning is made at this point.

3.3.3 Incidental learning

Incidental learning - sometimes also referred to as incidental learning, en-passant learning[45] , latent learning[46] , or accidental learning[47] - occurs without an intended learning or problem-solving goal and is thus a byproduct of other activities (Marsick & Watkins, 1990, p. 12; Mulder, 2013). It "occurs in situations where learning is not necessary, not planned, and not required" (Röhr-Sendlmaier & Käser, 2016, p. 210) and can be described as unexpectedly finding information while performing other activities (Williamson, 1998, p. 24). In principle, three categories of situations can be distinguished in which incidental learning can occur (Reischmann, 1995, p. 200): (1) in situations that are planned but where learning is not the main

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[44] For more examples on foreign language acquisition with regard to the other forms of learning, see Table 10 in Chapter 3.4.

[45] Cf. Reischmann, 1995

[46] Cf. Laur-Ernst, 2000, p. 164

[47] Cf. Hoffman, 2005, p. 3

purpose of the action (e.g., a trip); (2) in exceptional situations and isolated incidents (e.g., accident); (3) in work and life routines.

While almost all authors agree that incidential learning occurs non-intentionally or that attention is not focused on learning, there are different views on the consciousness of learning: Thus, the form of learning is sometimes described as conscious (Bennett, 2012), sometimes as unconscious (Röhr-Sendlmaier & Käser, 2016). An intermediate form is also considered possible: Incidental learning is "initially carried out without reflection" (Kirchhöfer, 2004, p. 85), but can be reflected upon by the learner afterwards, so that he or she becomes aware of his or her learning process (Schugurensky, 2000).

In connection with incidential learning, the term "implicit learning" is also frequently mentioned (cf. Reber, 1993). Overwien (2002) uses both terms synonymously and is of the opinion that they "originate from different theoretical contexts but refer to identical facts" (p. 18). Arnold (2016) uses the term "implicit learning" - following Polanyi's (1967) term of tacit knowledge ("tacit knowledge") and "en passant" learning according to Reischmann (1995) - basically meaningless to the definition of an unconscious, non-intentional learning. Eraut (2004) also mentions the term "implicit learning" and classifies it as a subordinate form in his typology of informal learning - in terms of content, however, he basically means nothing else than unconscious, incidential learning. In contrast to incidential learning, this paper does not consider "implicit learning" as a separate form of learning. Rather, the distinction between "implicit" and "explicit" in the sense of the characteristics of the dimension "awareness" serves as a criterion for the delimitation of learning forms (see chapter 3.2.2).

Apart from this, a distinction can be made between implicit and explicit *knowledge, which* can be acquired in the learning process through various forms of learning. Explicit knowledge is consciously available to the learner and can be retrieved for verbalization, while tacit knowledge[48] does not exist in a conscious and verbalizable form. However, through processes of automation, originally explicit knowledge can be transformed into tacit knowledge - an example is driving a car, which is initially learned explicitly but later exists primarily as tacit knowledge (Röhr-Sendlmaier & Käser, 2016, p. 218). Conversely, tacit knowledge can be at least partially transformed into explicable knowledge through reflection. Incidental learning usually leads to the acquisition of tacit knowledge. However, there are also experimental studies on the learning of complex linguistic structures that could empirically show that incidential learning can also lead, at least in part, to explicit knowledge (see Sendlmaier & Käser, 2016, for an overview).

In terms of the seven dimensions used to classify forms of learning, incidential learning has the following characteristics:

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[48] Synonymously, the term "tacit knowledge" is used (cf. Polanyi, 1967).

- *Structural specification*: Incidental learning does not involve externally specified structures - strictly speaking, it does not exhibit any structuring at all, since it can occur incidentally in any life situation.
- *Learning process responsibility*: In incidental learning, the responsibility for the learning process lies neither with the teacher nor with the learner, since learning does not take place consciously.
- *Learning situation*: Incidental learning can occur in any learning and work situation - directly at and also outside the workplace - and can be regarded as the "background noise" of any activity.
- *Awareness*: Incidental learning is implicit; thus, the learning process is not conscious to the person learning. However, through later reflection, an explication of the learning outcome and, to some extent, a cognitive tracing of the learning process is possible.
- *Intentional orientation*: Analogous to learning process responsibility, in incidential learning there is neither an intended learning goal nor an action goal of the learning person because of the unconsciousness of the learning process.
- *Spontaneity of the moment of learning*: Incidental learning occurs highly spontaneously and reactively in relation to everyday situations and actions.
- *Stimulus for goal setting*: Since incidential learning is not goal-directed but is incidental and random, the question of the stimulus for goal-setting does not arise.

This paper considers incidential learning and informal learning as distinct forms of learning - in contrast to Marsick and Watkins (1990, p. 12), who refer to incidental learning as a subcategory of informal learning. With regard to the seven dimensions for classifying forms of learning, incidental learning differs considerably not only from informal learning, but also from all other forms of learning: Incidental learning is the only one of the forms of learning considered here that is implicitly pronounced and thus not conscious to the person learning. For this reason - and since incidental learning can accompany any kind of situation or activity - no statement can be made about the learning process responsibility, the intentional orientation as well as the stimulus with regard to goal setting in the case of incidental learning. A common feature with informal learning, however, is that both forms of learning take place spontaneously and reactively.

3.3.4 *Self-regulated learning (self-regulated learning)*

Self-regulated learning is known under various largely synonymously related terms: In adult education one often speaks of self-directedness ([49]) of learning, in business-related fields such as human resource development of self-management (self-management), and in school/college education and cognitive psychology of self-regulation[50] (self-regulation) of learning (Raemdonck, Meurant, Balasse, Jacot & Frenay, 2014). Other terms considered to be approximately synonymous are self-determined or self-organized learning[51] (see Friedrich & Mandl, 1997, or Lang & Pätzold, 2006, for an overview of other terms from the English-speaking world; see also Sittner, 2006). The term "work-immanent learning", which originates from work psychology and focuses on the one hand on the visible work action and on the other hand on the underlying, non-visible psychological regulatory bases of the learning person, can also be located in this context (Sonntag & Stegmaier, 2007, p. 38). Before the concept of informal learning was introduced into work-related training research - and partly also afterwards (cf. Clardy, 2000) - the term "self-directed learning" was also used as a fuzzy collective term for more or less informal learning processes.

Unlike formal learning, in self-regulated learning the learner-not the teacher-takes primary responsibility for setting goals, implementing appropriate learning strategies, and assessing learning outcomes (Knowles, 1975). Although Knowles envisions a teacher in self-regulated learning[52], he encourages the reader of his work to replace the word "teacher" with "helper of any kind" (p. 7) if the learner is learning without a formal teacher but still wants social support (see Bell, 2017, for an overview of strategies to support self-regulated learning in the work context). Noß (2000) points out that "self-direction should not be equated with an absence of other-direction" (p. 16), as, strictly speaking, there would be no such thing as exclusively other-directed or other-regulated learning-ultimately, it is still the learner him/herself

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[49] Not to be confused is the process-related term of self-directedlearning as a learning concept used here and the personal characteristic of self-directed orientation with regard to learning (self-directed learning orientation, Raemdonck et al., 2014).

[50] In this paper, the term "self-regulated learning" is preferred to the other terms, as it seems to be the least controversial in research: while the other terms are defined and interpreted in different ways depending on the context, almost all authors who speak of "self-regulated learning" refer to relevant and mostly definitionally consistent standard works (e.g. Zimmerman, 1990 ; Pintrich, 2000).

[51] Erpenbeck & Heyse (1999 , p. 130), however, distinguish the terms "self-direction" (among other things, there must be a previously at least largely fixed goal, which can come both from the learning person himself or from an external source) and "self-organization" (among other things, there is *no* clearly defined goal - accordingly, the learning person has a greater uncertainty to cope with, but also more options for action). Dehnbostel (2008) agrees with this division and emphasizes that self-directed learning is not autonomous learning because of the "purposeful selection and determination of learning opportunities and learning paths" (p. 74).

[52] Knowles (1975) uses the term "self-directed learning."

who must expend the effort to acquire new knowledge and skills. Dehnbostel (2008) takes the same line: "The degree of this self-control varies, but no learning is possible without any self-control" (p. 75).

In contrast to Knowles, more recent work on self-regulated learning focuses more emphatically on the self-determined role of learners. Accordingly, Zimmerman (1990, p. 4) describes self-regulated learners as follows: They were aware of when they had knowledge or a particular skill in an area and when they did not. They proactively searched for information and took the necessary steps to acquire the required knowledge. Even in the face of obstructive learning conditions such as confusing statements from teachers or confusing textbooks, they would find their (own) way to learning success. Apart from Zimmerman's approach to a defined understanding of self-regulated learning (cf. also the earlier research work by Zimmerman and Pons, 1986), the definition by Pintrich (2000) in particular receives a lot of attention in the current literature:

Self-regulated learning is an active, constructive process in which the learner sets goals for his or her learning and also observes, regulates, and controls his or her cognitions, motivation, and behavior as a function of these goals and the given external circumstances. (p. 453; translation by Otto, Perels & Schmitz, 2015, p. 42)

Basically, three components of self-regulated learning can be distinguished (e.g., Boekaerts, 1999; Zimmerman, 2000; cf. Landmann, Perels, Otto, Schnick-Vollmer & Schmitz, 2015; Otto et al., 2015):

(1) Cognitive aspects (i.e., conceptual and strategic knowledge, combined with the ability to apply cognitive learning strategies).

(2) Metacognitive aspects (i.e., planning, self-observation, reflection, and adaptation of the learning process with respect to the pursued learning goal).

(3) Motivational aspects (i.e., activities to initiate and sustain learning in terms of volitional control, and actionable attributions to evaluate successes/failures and self-efficacy beliefs).

In terms of modeling self-regulated learning, process models (e.g., Pintrich, 2000; Schmitz & Wiese, 2006) can be roughly distinguished from layered models (e.g., Boekaerts, 1999) (see Panadero, 2017, for an overview). The process models "view self-regulation as an iterative, i.e., stepwise, loop-like process" (Landmann et al., 2015, p. 47) that can be divided into different stages. In contrast, the stratified models "do not focus on the temporal course of regulation, but consider the different levels" (p. 50) of (self-)regulation.

The concept of self-regulated learning, like numerous other forms of learning, was historically developed initially for the university context and thus for formalized learning

environments before being transferred to the workplace (Raemdonck et al., 2014). Friedrich and Mandl (1997), for example, cite quality circle, learning workshop, and other small group concepts as areas of application of self-regulated learning in an organizational context - but individual learning projects without direct social involvement are also conceivable. Sitzmann and Ely (2011) showed meta-analytically for the work context that the self-regulation constructs goal level, persistence, effort, and self-efficacy were most strongly related to learning or learning outcomes and - after controlling for the influence of cognitive abilities and prior knowledge - could explain 17% of the variance in learning. In contrast, the four self-regulatory processes of planning, monitoring, seeking help, and emotion control showed no significant relationship with learning. Overall, research on self-regulated learning predominates in the (high) school context, prompting Panadero (2017) to call for further studies, particularly longitudinal ones, on the use of self-regulated learning strategies in the workplace.

In terms of the seven dimensions used to classify forms of learning, self-regulated learning has the following characteristics:

- **Structural specification**: Self-regulated learning takes place independently of external structural specifications - even when it occurs in the context of formal educational institutions (e.g. , when a person participating in a formal course additionally sets his or her own learning goals).

- **Learning process responsibility**: The learning process responsibility in self-regulated learning lies solely with the learner.

- **Learning situation**: Self-regulated learning can occur directly in the workplace as well as outside the workplace - the decisive factor is that the learning person is in control of the learning process and thus also of the learning situation.

- **Awareness**: Self-regulated learning is explicit and thus conscious to the person learning.

- **Intentional orientation**: In self-regulated learning, the learner pursues a self-imposed learning goal. Accordingly, there is no intention to act, but an intention to learn.

- **Spontaneity of the learning moment**: The learning moment in self-regulated learning is planned by the learning person himself and can thus be considered "deliberate".

- **Stimulus for goal setting**: The stimulus for goal setting in self-regulated learning is internal - for example, the learner's need to expand his or her own competencies.

Self-regulated learning has some parallels to informal learning, including in particular the strong individuality of learning and the significant role that cognitive aspects play for both forms of learning (cf. the reflection components from the Octagon Model of Informal Learning,

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Decius et al., 2019). One difference, on the other hand, is that self-regulated learning in the work context often takes place in semi-structured environments, such as quality circles, even though there is usually no formally assigned teacher present there as in the (high) school context (cf. Friedrich & Mandl, 1997).

Even if self-regulated learning is defined in a context-independent "pure form" as a process with self-set learning goals and behavioral control as well as regulation to achieve these goals (cf. the aforementioned definition by Pintrich, 2000) and considered as work-related, individual learning (i.e. learning at the workplace, without the involvement of other persons), an essential contrast to informal learning emerges: the focus of action is on learning, whereas in informal learning it is on the execution of the work task. In other words, in informal learning, the learner sets the goal of solving a work-related problem (and must inevitably learn something in order to solve the problem); in self-regulated learning, the learner sets a specific learning goal, even independent of a trigger from the work task. In the former case of informal learning, the person thus monitors his or her work process and stops learning as soon as the problem is solved - in the latter case of self-regulated learning, the person monitors the achievement of his or her self-imposed learning goal and very likely interrupts his or her regular work task for the duration of the learning process. Thus, while informal learning is reactive, in self-regulated learning the timing is planned. Moreover, the stimulus for goal setting in informal learning is external, e.g., from challenges at work, but in self-regulated learning it is internal.

3.3.5 Deliberate Practice

Deliberate Practice[53] is a form of learning introduced into the literature by Ericsson, Krampe, and Tesch-Römer (1993) to explain the observation of why some individuals become high-performing experts in their field as they gain experience, but others remain at an average level of performance despite their experience (Ericsson, 2018). While innate ability seems to play a minor role in this, what matters more is expanding one's competence through intensive and strenuous practice over at least ten years until expert status is achieved (Ericsson et al, 1993).

Deliberate practice is characterized by the explicit goal of continuous skill and performance improvement through regularly repeated, always challenging practice activities (Sonnentag & Kleine, 2000). In doing so, it is important to consciously and through extra effort move beyond the point where routine and automated procedures are established in order to

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[53] In German, for example, "Bewusstes Üben" (conscious practice), "Bewusstes Lernen" (conscious learning), or "Reflektierte Praxis" (reflective practice); however, the English term is almost always used in German-language publications as well.

elevate one's performance to the next level (Ericsson, 2006). Typically, an experienced teacher or coach sets learning goals individualized to the learner's current performance level and provides immediate performance feedback, followed by repetition of practice behaviors in which the learner considers the previous feedback (see Ericsson, 2018). The entire, multi-year practice period culminates in a phase where the learning person outgrows their teacher's knowledge to make a unique, innovative contribution to the subject area (Ericsson et al., 1993). However, practice behavior can also be self-directed without support. In particular, as expertise increases, the learner takes more control, monitoring, and evaluation of his or her own performance and independently seeks to find and apply the best possible methods for further improvement (Van de Wiel, Van den Bossche & Koopmans, 2011, p. 4).

However, the performance requirements in different professions differ greatly, so that the characteristics of expert status are also strongly domain-specific. In the literature, a distinction is made between clearly defined and unclearly defined performance domains (e.g., Goller, 2017): Clearly defined domains are characterized by the fact that there is often a single, best solution or unambiguous rules for processing tasks and there are hardly any degrees of freedom with regard to interpreting the objectives. Performance can thus be assessed objectively to the greatest possible extent. The Deliberate Practice form of learning was originally referred to by Ericsson et al. (1993) only in these clearly defined domains, for example, performance in chess, sports, or music. However, most jobs involve tasks with less clearly defined goals or specifications for choosing a specific work method and thus fall into the ill-defined domains (Goller, 2017). Studies that attempted to apply the deliberate-practice concept to workplace learning predominantly showed - despite sometimes ambivalent results - that workers in ill-defined performance domains (including consultants, insurance agents, nurses) did not exhibit deliberate-practice behavior[54] (see Goller & Billett, 2014, for a review).

In terms of the seven dimensions used to classify forms of learning, Deliberate Practice has the following characteristics:

- *Structural specification*: Deliberate practice takes place independently of external, institutionally defined structural specifications. This does not preclude regular, repeated practice from following a strict, self-determined plan.
- *Learning process responsibility*: In Deliberate Practice, the responsibility for the learning process is borne by both the learner and the teacher[55]. In particular, the teacher is responsible for setting the learning objectives and providing direct

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[54] An exception is the qualitative study by Van de Wiel and Van den Bossche (2013) on deliberate practice among Dutch physicians (N = 45).

[55] Even if in the ideal-typical course a teacher is supporting, deliberate practice can also take place exclusively self-directed, especially from a higher expertise level of the learning person.

feedback on the learning process, while the learner is primarily responsible for carrying out the repeated practice passes.

- *Learning situation*: deliberate practice takes place in a protected "practice room" and thus outside the workplace[56] .
- *Awareness*: Deliberate Practice is explicit and thus the learner is aware of it.
- *Intentional focus*: Since Deliberate Practice is conducted for continuous performance improvement, a clear learning intention can be assumed.
- *Spontaneity of the learning moment*: The learning moment in Deliberate Practice is planned by the learner together with the teacher, so it is a "deliberate" moment.
- *Stimulus for goal setting*: As with the intentional orientation of deliberate practice, it should be noted here that the stated goal of improving performance is the focus of this form of learning. This goal arises out of the learner's desire to continuously improve his or her own performance - the stimulus is thus internal.

Deliberate Practice has some parallels to informal learning. For example, an important component of deliberate practice is continuous practice and trial and error, which is comparable to the component "Own trial and error" from the Octagon model (Decius et al., 2019), followed by performance feedback ("Direct feedback" component) and subsequent reflection ("Reflection afterwards" component). However, continuous practice in Deliberate Practice follows predetermined rules and does not result from triggers in the work process. Whereas in Informal Learning the work is the focus of the action and the learning is a means to the end of solving problems in the work process, in Deliberate Practice the focus is on the learning itself. For individuals in clearly defined performance domains (e.g., professional musicians), learning is even an important part, if not the main part, of daily work. Another difference is that learning in the context of deliberate practice, at least as originally defined, may be accompanied by direct performance feedback from an experienced teacher (shared learning process responsibility), whereas in informal learning the learner is self-directed and learns without external guidance - which does not preclude seeking feedback from others as well. In contrast to informal learning, Deliberate Practice takes place predominantly outside the workplace, is planned or deliberate, and the stimulus for goal setting is internal. Thus, Deliberate Practice shows more similarities to self-regulated learning, whereas in the latter the learning process responsibility clearly lies with the learning person and the learning process can take place both at and outside the workplace. In addition, deliberate practice is characterized in particular by

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[56] For example, the classical professional groups on which Deliberate Practice has been primarily studied perform their practices outside of professional competitive situations (athletes, chess players) and performance situations (musicians).

its long-term perspective, which involves building up expertise in a narrowly defined area, possibly over years or decades, whereas self-regulated learning is not so fixed in time.

3.3.6 Autonomous learning

The concept of autonomous learning has so far been discussed mainly in the context of foreign language learning (e.g., Nielson, 2011; see Benson, 2007, for a review) or in the field of university learning (e.g., Clifford, 1999). In particular, Holec's (1981, p. 3) definition has become well known, describing autonomous learning in terms of the learner's ability to take responsibility for his or her own learning. The learner determines his or her own learning goals and the content to be learned, selects the methods and techniques to be used, monitors the learning process, and evaluates the learning outcome. This definition is almost identical to that of self-regulated learning (see chapter 3.3.4). Thus, it is not surprising that some authors use the terms "autonomous learning" and "self-directed learning" synonymously (e.g. MacKeracher, 2004, p. 19.). Kyndt & Beausaert (2017) note: "In sum, autonomous learning at the workplace involves all learning activities that are self-directed in nature" (p. 204).

Noe and Ellingson (2017) refer to Holec (1981) and transfer autonomous learning to the work context. They see the term "autonomous learning" as a collective term for different learning concepts in which the self-direction by the learning person is in the foreground - among others, they mention self-determined or self-regulated learning as well as informal learning[57]. They define autonomous learning by four characteristics (cf. Noe and Ellingson, 2017, p. 3): First, it is *voluntary* learning in which the learner actively participates and contributes to the learning process without external control. Second, autonomous learning involves *unstructured* experiences, i.e., there are no predetermined or planned learning goals and no determination of the learning content or process. Third, autonomous learning creates *human capital*. By this is meant that employees - despite all freedom to determine their learning behavior - must build up knowledge or skills relevant to the job or career in order to speak of autonomous learning. Fourth, autonomous learning is *neither administratively nor operationally supported by the organization* - but an indirect promotion of learning through a positive organizational culture or the appreciation of a lifelong learning philosophy is possible.

However, Ployhart, Call, and McFarland (2017) point out that autonomous learning is triggered by a need to learn that may arise as a consequence of an activity or even a negative performance evaluation. This view runs counter to Noe and Ellingson's (2017) criteria of voluntariness as well as the absence of self-imposed learning goals. Kraiger (2017, p. 311) proposes a definition that focuses on the self-determination of the learner in terms of learning

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[57] In a very similar vein, Noe et al. (2014) use the collective term "continuous learning" for this in an earlier study.

goals, learning interruptions, as well as the termination of learning. Autonomous learning typically occurs outside of formal training and is rooted in work experiences. It requires the learner to take responsibility for gathering information and feedback and to be open to support from others. In contrast, Zhan, Noe, and Ellingson (2018, p. 6), following Parker and Collins (2010), view autonomous learning as a specific type of proactive behavior[58] in the domain of learning that occurs when a person identifies a need to learn.

Autonomous learning can further be associated with the concept of taking charge, which is considered a specific form of extra roles behavior (Morrison & Phelps, 1999). Sonntag and Stegmaier (2007) see this approach as significant for learning in the work context, insofar as in this way "employees change their task, role, or processes of the organization in such a way that organizational goals can be pursued more successfully" (p. 54). Furthermore, they establish a connection to the concept of job crafting, which, however, focuses more on changes with regard to individual goals of the employees (Wrzesniewski & Dutton, 2001).

Depending on the definitional perspective, the term autonomous learning as described can either be used synonymously with self-regulated learning (cf. Holec, 1981), or is used as a collective term for various types of learning (cf. Kraiger, 2017; Noe & Ellingson, 2017). For this reason, autonomous learning is not considered as a separate form of learning in this paper, so there is no separate differentiation from informal learning.

3.3.7 Experiential learning (experiential learning)

In the context of experiential learning, experience can be defined as the interaction between a learner and his or her social, psychological, and material environment ("learning milieu," Boud & Walker, 1990, p. 62). Already Dewey (1938) assumed that experiences are central to the learning process and that a personal experience in turn leads to further experiences. In this context, individual learning is shaped by prior personal experience, which is derived from the social and cultural environment on the one hand, and from previous knowledge and achievements of the learning person on the other hand (Boud & Walker, 1990, p. 63)[59] . By having their own experiences, the learning person also gets the opportunity to directly apply their knowledge, learn from the interplay of trial and error, and strengthen their own self-efficacy (Manolis, Burns, Assudani & Chinta, 2013). Thus, experiential learning is based on the

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[58] Proactive behavior involves (1) acting in anticipation of future problems, needs, or changes; (2) taking control and bringing about change; and (3) developing initiative to improve a situation or oneself (Parker & Collins, 2010 , pp. 634-635).

[59] The Australian scholars David Boud and David Walker give an illustrative example: a student with an Aboriginal background would probably associate different ideas, thoughts, and experiences with a university-organized "field trip" out into the country than would be the case for a student with a European ancestry background (1990, p. 63).

construct of self-efficacy, the most important influencing factor of which is, in turn, personal experience (cf. Bandura, 1991).

The term "experiential learning" is often interpreted broadly in terms of content, which in the past has led to "conceptual ambiguity" and "semantic chaos" (Malinen, 2000, p. 15). Regardless of the theoretical inconsistency regarding a conceptualization, experiential learning is considered an effective educational approach from a practical standpoint because it strengthens learners' metacognitive skills and their ability to apply information to new situations, enabling them to become self-directed learners in the future (Kolb & Kolb, 2005; Manolis et al., 2013). Experiential learning can take place both outside and inside didactically prepared learning environments (Laur-Ernst, 2000, pp. 164-166). The role of the teacher - if present - in this form of learning is therefore to organize and support the learners' individually needed experiences, not to convey information (Manolis et al., 2013).

Probably the most significant model of experiential learning is that of Kolb (1971, 1984, 2007), although it has been sharply criticized in recent times from a modeling perspective (see Bergsteiner, Avery & Neumann, 2010). Kolb (1984, p. 20) states that his model builds on the intellectual roots of the work of John Dewey, Kurt Lewin, and Jean Piaget. He defines experiential learning as a process in which knowledge is generated through the transformation of experience (p. 38). Two continua confront each other in Kolb's model: First, the dimension of acquiring experience with the poles of "Abstract Conceptualization" and "Concrete Experience," and second, the dimension of transforming experience with the poles of "Reflective Observation" and "Active Experimentation." Knowledge acquisition involves a "creative tension" between these four modes that responds to contextual demands (Kolb & Kolb, 2005, p. 194). For example, an error may occur in the work process that cannot be resolved with the person's previous knowledge. The gap between the previous knowledge and the new error experience is then closed by the learning process (Harteis, Bauer & Heid, 2012). According to Holman, Pavlica, and Thorpe (1997, p. 137), the modes can be described in terms of the following behaviors and skills, and thus have some similarities in content to the components of the Octagon model of informal learning (Decius et al., 2019):

(1) "Abstract conceptualization" includes, among other things, logical reasoning, analyzing quantitative data, testing theories and developing conceptual models, and experimenting with new ideas. Here, certain similarities to the reflection components from the Octagon model are apparent - however, "abstract conceptualization" focuses on a deeper, analytical approach that goes beyond pure, work-related reflection through the targeted development of new approaches to solutions.

(2) "Concrete experience" includes, among other things, interaction with other people and their values and feelings, personal involvement as well as intuitive experience and empathy. Although interaction with other people also plays an important role in the components

"Direct feedback" and "Substitute feedback" from the octagon model, the focus there is on a work (result)-related exchange, rather than on the interaction partner him/herself.

(3) "Reflective observation" includes information gathering and critical thinking. Thus, this aspect shows a similarity to the Octagon Model components "model learning" and "hindsight reflection." "Model learning," however, is more focused on the transfer of successful behavior and thus less cognitive than "reflective observation."

(4) "Active experimentation" includes seeking and exploiting opportunities that arise, setting and pursuing goals, making decisions, as well as risk-taking and entrepreneurial skills. From its name, one might think that this aspect is similar to the "Trying things out for oneself" component from the Octagon model - however, "active experimentation" focuses more on conscious, goal-oriented and action-oriented learning, not on applying one's own ideas to solve problems.

The four modes are arranged in the following cycle without a fixed starting and ending point (Kolb, 1984), even though a concrete experience is often the starting point (Segers & Van der Haar, 2011, p. 56): "Concrete Experience" (performing an activity or Experiencing an action to see the effect of the action in *this* situation) leads to "Reflective Observation" (to understand and interpret the effect in *this* situation), which in turn leads to "Abstract Conceptualization" (deriving the *general principle* behind the effect to gain implications for future actions), which in turn leads to "Active Experimentation" (actively testing these implications, also including feedback from other people), which in turn leads to "Concrete Experience" and thus closes the circle.

Apart from this ideal-typical cycle, it often happens in reality that only one of the four modes is used by the learning person - also with regard to the assumption that not every person masters or prefers all modes to the same extent (Segers & Van der Haar, 2011). Moreover, each of the two modes of experience acquisition or experience transformation cannot be used simultaneously in a given situation - the learning person must choose[60] .

While Boud and Walker (1990, p. 62) emphasize reflection in experiential learning and predominantly assume that this form of learning is deliberate and planned, Kolb (1984) emphasizes more strongly the additional possibility that learning can also take place spontaneously (through concrete experience or active experimentation), for example also starting from a conflict or contradiction to one's own thinking. Both aspects of the timing of learning (spontaneous and deliberate) thus seem plausible. Likewise, the intention underlying experiential learning can be diverse: on the one hand, the intention can be linked to the values and ideals

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[60] For example, it is nearly impossible to take the newly purchased bicycle for a test ride ("Concrete Experience") and *at the same time* study the manual extensively to find out about the use of the gears ("Abstract Conceptualization"); this conflict can be resolved by deciding on a mode (Segers & Van der Haar, 2011 , p. 57).

of the person learning and there can be a conscious focus on learning (learning intention); on the other hand, it can be a wholly pragmatic response to a situation at hand (action intention; Boud & Walker, 1990, p. 64). This ambiguity is also evident in Kolb's model: While the modes "Concrete Experience" and "Active Experimentation" tend to be assigned to the intention to act, the modes "Reflective Observation" and "Abstract Conceptualization" tend to speak for the presence of a decided learning goal. Therefore, it can be stated that experiential learning is quite heterogeneous with regard to both the time and the learning intention.

In terms of the seven dimensions used to classify forms of learning, experiential learning has the following characteristics:

- *Structure specification*: Experience-oriented learning takes place independently of external structure specifications.

- *Learning process responsibility*: Even though in experiential learning a teacher may be involved in the learning process as an advising and reflecting subject (which is rarely the case in practice anyway), the responsibility for the learning process lies with the learner.

- *Learning situation*: The learning process in experiential learning can take place both in the direct context of the work situation (primarily within the framework of the components "Concrete Experience" and "Active Experimentation") and outside of work organizational processes (primarily within the framework of the components "Reflective Observation" and "Abstract Conceptualization").

- *Awareness*: experiential learning is explicit and thus conscious to the person learning.

- *Intentional orientation*: Depending on the theoretical conceptualization (see above), experiential learning can focus on both the intention to act and the intention to learn.

- *Spontaneity of the learning moment*: Also for the spontaneity of the learning moment it is true that, depending on the theoretical conceptualization, experiential learning occurs predominantly spontaneously and reactively or planned and deliberate.

- *Goal-setting stimulus*: In experiential learning, there is an internal stimulus to goal setting because the person learning wants to analyze his or her experiences to better prepare for future events.

Experiential learning and informal learning have in common that both forms of learning ascribe great importance to personal experience, reflection as well as interactive exchange with other persons, albeit to different degrees. An important difference is that the stimulus for goal setting in informal learning is external from the task and internal from the person in experiential learning. Whereas in the case of informal learning one characteristic clearly prevails in the

learning situation as well as in the case of the intentional orientation and the spontaneity of the learning moment, in the case of experience-based learning both characteristics are possible for all three dimensions, depending on the conceptualization.

3.3.8   Action-oriented learning (action learning)

Closely related to experiential learning is action learning. Revans (1980; 1982), considered one of the pioneers in this field, defines action learning as a means of individual development whereby the learner participates responsibly in solving a real, complex, and challenging problem. It draws on the learner's experiences and needs, rather than a teacher's knowledge-typical learning behaviors include experimentation, questioning, and reflection (O'Leary, Coughlan, Rigg & Coghlan, 2017). Revans (1982) sums it up with the following formula: learning = "programmed" knowledge from the past + questioning insight. In addition to the characteristics of "taking responsibility for problem solving" and "realism of the problem," Pedler (1991) also highlights that action-based learning takes place in a social context where colleagues support and also questioningly challenge each other to advance problem solving.

Marsick and O'Neill (1999) emphasize that many researchers consider Kolb's (1984) experiential learning as the theoretical basis of action-based learning. In some cases, the two terms are also used interchangeably because they are based on similar philosophical assumptions (Zuber-Skerritt, 2002; see also Beaty & McGill, 2013). Marsick and Watkins (2001) refer to action-based learning as a variant of experiential learning, while Marquardt (2007) refers to it as an effective methodology of this form of learning.

This paper subscribes to the view of the "experiential" school of thought that action-based learning is a focused manifestation within the broader construct of experiential learning (see Marsick & O'Neill, 1999, for an overview of the various schools of thought on action-based learning). Therefore, no separate distinction of action-based learning from informal learning will be made here.

3.3.9   Transformational learning

Transformational[61] Learning according to Mezirow (1990; first mentioned as a term by Mezirow, 1978; developed several times in the following years, cf. Kitchenham, 2008) is a learning process in which personal experience is interpreted and thus one's own frame of reference is changed, which determines how a person sees, evaluates and interprets the (surrounding) world. The frame of reference may change, for example, as a result of a life event or an incisive experience ("disorienting dilemma," Mezirow, 2000, p. 22), resulting in a

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[61] Sometimes the terms "transformative learning" and "transformational learning" are used synonymously in the literature.

transformation of the learning person's perspective (Mezirow, 1997). However, the learning person can also actively bring about this change, namely through critical self-reflection or seeking out uncomfortable situations (i.e., stepping out of the "comfort zone") to enable a more comprehensive, nuanced, and integrative understanding of one's experiences (Mezirow, 1991). Such a conscious decision as a trigger of the transformational learning process is comparable to choosing to participate in therapy or a self-help group (Marsick & Watkins, 1990, p. 227). Insofar as the person wants to change themselves through active learning, the focus is on a learning intention; insofar as the person wants to solve their problem ("dilemma") and remedy the disruption of their worldview, the focus is on an action intention. In the case that a teacher is involved in the learning process, however, the teacher is merely supportive and can, for example, stimulate critical self-reflection via targeted questions (Segers & de Greef, 2011).

The change in one's own perspective or frame of reference can ultimately be followed by a change in one's own actions - this action based on the reflected insights is then referred to as transformational learning. Experiences play a double role in this context: On the one hand, they form the mental framework for the interpretation of practice; on the other hand, the concrete practical experience functions as the initial spark of a learning process (Harteis et al., 2012). In the work context, transformational learning also plays a role when, for example, there are upheavals in the established organizational culture (Segers & de Greef, 2011).

The importance of reflection for learning in Mezirow's theory is consistent with previous research on reflective work practice (see Schön, 1983). Mezirow (1997, p. 60) describes three phases of transformational learning: (1) a critical reflection on one's practice experiences and assumptions; (2) a discourse[62] on the outcome of the critical reflection; (3) action as application and testing of the newly developed knowledge. According to Mezirow (1991), the phase of critical reflection involves ten steps in this process (cf. Segers and de Greef, 2011, p. 43):

(1) Identifying a "disorienting dilemma".

(2) Review of own assumptions

(3) Critical evaluation of the assumptions

(4) Recognition that others have experienced similar transformations

(5) Exploration of new roles or actions

(6) Development of an action plan

(7) Acquire knowledge and skills to implement the plan.

(8) Trying out the plan

(9) Development of competence and self-confidence in the new role

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[62] Here Mezirow (2003 , p. 61) refers to Jürgen Habermas' (1984) concept of discourse: "For Habermas, discourse is an organizing principle of democratic judgment and legitimacy" (Warren, 1995 , pp. 167-171).

(10)   "Reintegration into life" based on new, transformed perspectives.

Criticisms of transformational learning theory have included its heavy focus on critical self-reflection and the accompanying individual transformation, with little consideration of social interaction (e.g., Newman, 1994; Taylor, 1997; see Segers & de Greef, 2011 , pp. 45-47, for a review)[63] .

In terms of the seven dimensions used to classify forms of learning, transformational learning has the following characteristics:

- *Structural specification*: Transformational learning takes place independently of external structural specifications.

- *Learning process responsibility*: The learning process responsibility in transformational learning lies with the learning person.

- *Learning situation*: Since transformational learning is closely linked to the triggering incisive experience ("disorienting dilemma"), it is strongly interwoven with the work process and tends to take place in the workplace rather than outside it[64] . However, the learning person may leave the workplace temporarily during the learning process, e.g. for discourse about his or her reflection result with other people.

- *Awareness*: Transformational learning is explicit and thus conscious to the person learning.

- *Intentional focus*: Based on the assumption that the learning person wants to solve the "dilemma" he or she is experiencing, the intention to act (problem-solving intention) is the focus of transformational learning.

- *Spontaneity of the learning moment*: Transformational learning can occur on the one hand as a spontaneous reaction to an experienced event or a "dilemma"; however, it can also be "deliberate" learning on the other hand, when the person enters the learning process in a planned way and on the basis of a conscious decision.

- *Stimulus for goal setting*: Even though the trigger of a transformational learning process can be brought to the learning person from the outside by an experienced event, the goal setting, however, takes place internally. The reason for this is that the learning person wants to consciously and critically reflect on his or her views and behavior and thus "transform" him or herself. Despite an external impulse, the learning person therefore does not expect an external "reward" (e.g. in the

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[63] However, in a response to Newman's (1994) critique, Mezirow (1997) emphasizes the embeddedness of all learning in a social context and finds himself misunderstood: "What I have tried, apparently unsuccessfully, to communicate is that learning is fundamentally *social*" (p. 61).

[64] An example of such a "dilemma" in the work context could be an occupational accident that was facilitated by the negligent or even intentional disregard of safety regulations.

sense of a problem solution in the work process, as is the case with informal learning) for his or her transformation efforts forced on his or her own initiative.

Marsick and Neaman (2018, p. 61) make a connection between Mezirow's transformational learning and informal learning. They note that the iterative cycles of transformational learning led to greater accuracy in diagnosing and designing situations where informal learning was required. Transformational learning and informal learning also share the commonality that reflection on one's own work plays an important role. However, while only two of eight components in the octagon model of informal learning (Decius et al., 2019) address reflection before and after the work task, reflection is much more prominent in transformational learning. Informal learning, on the other hand, more strongly involves social interaction (feedback, model learning). The learning process responsibility as well as the intentional orientation of both forms of learning are very similar. However, a difference arises in the spontaneity of the learning moment, since transformational learning can take place spontaneously as well as planned, while informal learning always occurs spontaneously as a reaction to requirements of the work process. Furthermore, the stimulus for setting goals in transformational learning comes internally from the person, and not externally from the work situation as in informal learning.

Transformational learning, on the other hand, is very similar to experiential learning (Segers et al., 2018). This is already evident in Kolb (1984, p. 38), who defines experiential learning as a process in which knowledge is generated through the transformation of experiences. With regard to the classification based on the seven dimensions of learning forms, however, differences in the intentional orientation as well as in the learning situation are also recognizable, even if they are only marginal: While transformational learning has an intention to act, in experiential learning both an intention to act and an intention to learn are possible. Furthermore, transformational learning usually takes place directly in the work situation, while experiential learning can also take place outside the workplace.

3.3.10 Expansive learning (expansive learning)

Engeström's (1987) theory of expansive learning builds on the cultural-historical activity theory of Russian psychologists Leont'ev, Luria, and Vygotskij from the 1920s and 1930s (e.g., Leont'ev, 1981; Vygotskij, 1978; cf. Engeström, 1999[a] ; 2009). Unlike other learning concepts, expansive learning addresses the learning process of teams or organizations, not the individual level (Segers et al., 2018). Engeström based the concept of expansive learning on "learning III" from Bateson's (1972) concept of three stages of learning[65] , but which focuses on the

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[65] According to Bateson (1972) , "learning I" involves the reinforcement of behavior through reward and punishment; "learning II" involves the behavioral rules of the context through socialization (e.g.,

individual's learning. "Learning III" means that a person begins to radically question the meaning and significance of the current context and to create an extensive, alternative context. In this way, the person distances him/herself from the given context in order to construct a larger context - thus expanding the big picture (Dochy, Engeström, Sannino & Meeuwen, 2011).

In terms of the sequence of learning activity in a group, the expansive learning cycle ideally comprises the following seven steps (Engeström, 1999[b] , p. 384; see Dochy, Engeström et al., 2011, for a summary worth reading):

(1) Raising questions/critical questioning

(2) Analysis of the past and the current situation

(3) Modeling the new situation

(4) Study of the new model

(5) Implementation of the new model

(6) Reflection of the overall process

(7) Consolidation and generalization of the newly learned practice

In the organizational context, the process is most often supported by a coordinating person who accompanies the team or the entire organization to the next stage of the cycle. The cycle of expansive learning can be understood as a theoretical generalization of how new activities and practices emerge in a work community (Dochy, Engeström et al., 2011). Therefore, as Fuller and Unwin (2004) critically note, expansive learning does not represent an individual form of learning, but rather a methodology for transforming the organizational context or change management (see also Theory of Organizational Learning, Argyris & Schön, 1996; Concept of the Learning Organization, Senge, 1990). The present work agrees with this interpretation, so that no demarcation from informal learning at the workplace is made at this point.

3.3.11 Situated learning

The approach of situated learning goes back to Lave and Wenger (1991). At the center of this form of learning is the model of *legitimate peripheral participation*. By this, Lave and Wenger mean the participation of learners in a practice-based community ("community of practice"). At its simplest, a community of practice[66] can be a group of people who work together for a

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the "hidden curriculum" ["hidden curriculum] through which students implicitly learn, among other things, how to behave in the study context in addition to the study content; cf. Dochy, Engeström et al., 2011).

[66] Lave and Wenger (1991) relate their concept also, but not exclusively, to work-related learning situations. In a later work Wenger (1998) again explicitly points out the context-independent ubiquity of practice-related communities: "We all belong to communities of practice. At home, at work, at school, in our hobbies - we belong to several communities of practice at any given time. And the communities of practice to which we belong change over the course of our lives. In fact, communities of practice are everywhere" (p. 6).

period of time without having to be formally assembled as a team (Brown & Gray, 1995). For inexperienced learners ("newcomers") to acquire knowledge and skills, they would need to be introduced to the community's sociocultural ways of working and practices (e.g., norms, values, relationships, and beliefs), according to Lave and Wenger (1991). Initially, learners would take on simpler, yet important, tasks within the community. Through peripheral activities that take place alongside the actual work (e.g., conversations with colleagues) would introduce them to the community. Over time, the "newcomers" would become "old-timers" and could take on more responsible tasks. As experts in their field, the "old-timers" can also be the teachers in the context of situated learning. Participation in the community is described as legitimate, as the presence of the "newcomers" is accepted by the "old-timers". Situated learning is thus seen as a social process of knowledge construction in a particular context, embedded in a certain social and physical environment (Lave & Wenger, 1991). In the context of industrial work, the community referred to may be, for example, a work team or, thought of on a larger scale, an entire shift workforce.

The situated learning approach has sometimes been seen as too "static" in relation to the work context, and the model's one-way street of learning process control and knowledge generation from teacher to learner has been criticized (see Cairns & Stephenson, 2009, for a review). Billett (2004[a], 2004[b]) draws on Lave and Wenger's approach and, while also emphasizing the importance of learner participation within the community, focuses more on the opportunities and constraints within the social fabric and incorporates the agency and individual biography of the learner. Specifically, Billett distinguishes (1) the extent to which a person has the opportunity to participate in activities and interact with work colleagues and (2) the extent to which the person chooses to take advantage of available opportunities to participate (Fuller, Munro & Rainbird, 2004, p. 9).

In terms of the seven dimensions used to classify forms of learning, situated learning has the following characteristics:

- *Structural specification*: Situated learning takes place independently of external, formal structural specifications. Only traditional values and norms within the practice-oriented community provide the structure.
- *Learning process responsibility*: The learning process responsibility lies both with the learning persons ("newcomers"), who try to integrate into the community, and with the "teachers" ("old-timers"), who steer and "legitimize" the integration process considerably, even if little visible to the outside.
- *Learning situation*: The learning process in situated learning takes place directly in the work process - among other things by involving the learning persons and assigning work tasks as well as through discussions and exchange of experiences.

- *Awareness*: situated learning is largely explicit and thus conscious to the person learning[67] .
- *Intentional Orientation*: in situated learning, the learner holds an intention to act, namely to get along and integrate as fully as possible into the practice-based community.
- *Spontaneity of learning timing*: situated learning occurs spontaneously through the "peripheral participation" of the person learning, for example, by working directly with more experienced people and in response to interactions and conversations.
- *Stimulus to goal setting*: The stimulus to goal setting is external and occurs through the (often unspoken) requirement for the learner to integrate into the practice-based community.

Situated learning takes place in the same context or work-related community in which the resulting learning outcomes are also applied (Billett, 1996). This - as well as the intention to act that is pronounced in both forms of learning - represents a commonality with informal learning, in which both the learning process and the application of what is learned take place in the workplace. A key difference between the two forms of learning is the social embeddedness of the learning: in situated learning, social control is high, as the social environment partly appears in the role of the teacher - the learning process responsibility is shared. In informal learning, although some components also involve interaction with other, possibly more experienced, individuals (cf. the components of model learning, direct feedback, and vicarious feedback in the Octagon model of Decius et al., 2019), responsibility and control over the learning process remains solely with the learner: the learning process is largely self-directed and individual-oriented; there is no external teacher. In addition, both forms of learning also differ from each other in *what* is mainly learned. Hodkinson and Hodkinson (2004, p. 261) distinguish between (1) learning things that are already known to others; (2) developing existing skills; and (3) learning things that are new (or treated as such) in the workplace. While both forms of learning address the second aspect, situated learning targets the first aspect more strongly, and informal learning in terms of problem solving targets the third more strongly. Apart from that, situated learning shows the greatest similarity to informal learning of all forms of learning presented here.

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[67] In situated learning - as in principle in all other predominantly explicit forms of learning as well, even if to a lesser extent in some cases - part of the learning process may be implicit and only become accessible to the learning person in retrospect through reflection. Transferred values and norms should be mentioned here, for example: The learning person does consciously perceive that he or she is adopting the customs of the community - but without necessarily having explicitly noticed the underlying values.

3.3.12 Work-based learning

Work-based learning is a form of learning that has been the focus of research, especially in the late 1980s and 1990s. Most authors describe work-based learning as an important learning component in (high) school education (e.g., Hamilton & Hamilton, 1997; Raelin, 1997; Saunders, 1995), for example, through the performance of paid or unpaid work (Garnett, 1997, as cited in Gray, 2001). Work-based learning, he argues, is a means to increase student engagement in learning and prepare young people for future employment (Hamilton & Hamilton, 1997).

Work-based learning is also described as learning aimed at understanding the job role (Levy, Oates, Hunt & Dobson, 1989, as cited in Little & Brennan, 1996) or the demands of the job (Seagraves, 1996). Hamilton and Hamilton (1997) focus on the intensity of the work experience and distinguish (1) on-the-job visits, which include field trips (i.e., one-time visits for observation) and job shadowing; (2) work-like experiences, primarily (unpaid) internships and youth-led (micro) enterprise projects; (3) long-term employment (temporary jobs, longer paid internships, apprenticeships/training).

Seagraves (1996, p. 14) distinguishes three situations in which work-based learning occurs-apparently, as Cox (2005) notes, following Schön's (1983) typology of reflection: (1) "learning for work" (e.g., at school, college, or home); (2) "learning at work" (e.g., training and development opportunities provided by companies for students); and (3) "learning through work" (integrated into the performance of the job; see Schaper, 2004, for the design of work-integrated learning environments). Here, Seagraves (1996) argues that the first two learning aspects should be considered useful only when reinforced by the "learning through work" aspect.

Work-based learning is often formalized through collaborations between educational institutions and businesses to best support learners. The following interrelated components are identified by Levy et al. (1989, p. 4; as cited in Little & Brennan, 1996, p. 3) as each making a significant contribution to work-based learning: (1) structuring workplace learning; (2) providing appropriate on-the-job training and learning opportunities; (3) identifying and providing relevant off-the-job learning opportunities.

Raelin (1997) incorporates the theoretical perspective in addition to the practical perspective already focused on by other authors. In developing his model of work-based learning at the individual level in the form of a four-field matrix, he borrows from Kolb's (1984) concept of experiential learning. In doing so, he distinguishes the aspects "explicit" and "tacit" on the knowledge level and the aspects "theory" and "practice" on the learning level. The combination *explicit/theory* results in the learning behavior "conceptualization" (e.g., mastering new

problems in different contexts), *explicit/practice results in* "reflection" (e.g., reviewing and refor-mulating one's own goals), *tacit/theory results in* "experimentation" (e.g., solving case studies, simulations), *tacit/practice* results in "experience" (e.g., acquiring unconscious experiential knowledge by working on tasks).

The term "work-based learning" is also occasionally used as a collective term for various learning concepts outside of the form of learning presented here, as Poell (2013, p. 21) also critically notes. Lester and Costley (2010), for example, describe work-based learning as all that learning that is situated in the workplace or that arises directly from workplace concerns. However, the majority of research - including the present work (cf. chapter 3.4) - rather uses the term "work-based learning" for such a broad understanding (e.g., Kyndt & Baert, 2013; Sambrook, 2005; cf. Schaper, 2000, pp. 21-25).

In terms of the seven dimensions used to classify forms of learning, work-based learning has the following characteristics:

- *Structure specification*: Work-based learning is based on external and formally specified structures, which, however, usually contain more degrees of freedom than curricula within the framework of formal learning (e.g. structure of a school or student internship).

- *Learning process responsibility*: The responsibility in the learning process is shared between the educational institution or the organization involved in the work-based learning (e.g. internship site) on the one hand and the learning person on the other hand. While the institutional side is responsible for the framework of the work-based learning, the learner is responsible for the implementation of the learning process on site and the resulting gain in experience.

- *Learning situation*: Work-based learning can take place both directly in the work process (e.g. in the case of internships or as part of the practical components of apprenticeships or training) and outside the workplace, namely work-related (e.g. job shadowing) and, less frequently, work-oriented (e.g. internship preparation at home).

- *Awareness*: Work-based learning is explicit and thus the learner is aware of it.

- *Intentional focus*: Work-based learning focuses on the intention to learn - especially in the most common learning opportunities of this form of learning, such as internships and vocational training.

- *Spontaneity of learning timing*: work-based learning takes place in a planned and thus "deliberate" manner[68].

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[68] For example, scheduling times for internships exist in degree plans.

- *Stimulus for goal setting*: Goal setting in work-based learning occurs through an external stimulus that results from the structural requirements of the institution or business organization that is responsible for providing the framework for the learning process.

In the case of work-based learning, a parallel to informal learning can be seen, since both forms of learning show a high degree of reference to the processing of work tasks, which, for example, is much less present in formal learning. Apart from Seagraves' (1996) "learning for work", the learning behavior in each case takes place directly in the workplace. The reflection aspect from Raelin's (1997) model is also comparable to the reflection components in the Octagon model (Decius et al., 2019). The aspects "conceptualization" and "experimentation" are similar to the component "own trying out", as each involves trying out and applying one's own problem-solving strategies.

Apart from this, work-based learning is more closely related to formal learning, as both forms of learning are dependent on external structural requirements, focus on a learning intention, and the learning process is planned and deliberate. In addition, work-based learning requires the formal involvement of experts or teachers, which is often achieved through the cooperation of educational institutions and companies. In informal learning, on the other hand, the learner takes a more active role, which is only partially given in work-based learning - in internships and long-term employment rather than in excursions and job shadowing (cf. learning situations according to Hamilton & Hamilton, 1997). In addition, the focus of work-based learning is mainly on persons in vocational (initial) training, whereas informal learning is not limited to a specific target group (long-term employees can learn informally as well as trainees and interns). However, scenarios are also conceivable in which (also older) employees learn in a similar work-based way as apprentices, for example through cross-departmental job shadowing in the same company or through retraining and instruction.

3.3.13 Other learning concepts

For the sake of completeness, it should be mentioned that other learning concepts exist in school and university education that go beyond classical learning in the classroom, but rarely relate directly to the work context. The approaches have in common the focus on more or less supported, basically self-determined problem solving by the learners. These learning concepts can partly be seen as special manifestations of work-based learning or as methods for enriching formal learning with interactive and practical elements.

This includes problem-based learning, which is particularly common in medical education, where students acquire knowledge and skills by solving an open problem within a scenario (Barrows, 1996; Wood, 2003). The specific learning objective is largely self-determined

by the learners based on the "triggers" of the given scenario (Wood, 2003). From a cognitive perspective, learners develop mental models relevant to problem solving (Schmidt, Rotgans & Yew, 2011).

A similar approach is team-based learning, the concept of which was developed in response to ever-increasing course sizes, lack of funding, and decreasing availability of faculty in higher education (Michaelsen, Watson, Cragin & Fink, 1982). In this form of learning, learning also occurs through problem solving; however, the focus is even more on collaboration within the group. Team-based learning involves four sequential steps (Michaelsen & Sweet, 2011):

(1) (Strategic) composition of the cooperative student teams.

(2) Conducting preparatory tests incl. discussion of results to standardize the level of knowledge ("readiness assurance process")

(3) Work on application-based tasks that promote both critical thinking and team development

(4) Peer Evaluation

The related concept of project-based **learning** (project-based leanring) was developed to motivate students to deal with authentic problems (Blumenfeld et al., 1991). Here, the focus is less on the team and more on the project task to be worked on. Learners acquire knowledge through their own explorations and investigations and develop collaborative projects that reflect their knowledge (Bell, 2010). In this process, students are given the opportunity to work relatively autonomously over extended periods of time to develop a real-world product or create a presentation (Thomas, 2000). Krajcik and Blumenfeld (2005) classify project-based learning as a subtype of situated learning. Similar methodological approaches can also be identified in continuing vocational training ("learning projects", cf. Schaper, Mann & Hochholdinger, 2009).

Inquiry-based learning - going back to early research by Schwab (1960) and Herron (1971) - is based on the fact that learners, most of whom are students, "(co-)design, experience and reflect on the process of a research project [...] from the development of questions and hypotheses to the choice and execution of methods to the testing and presentation of results [...]" (Huber, 2009, p. 11). Learners thus use methods and practices similar to those of professional scientists to actively, collaboratively, and autonomously construct knowledge, test hypotheses, and experiment with problem-solving strategies (Pedaste et al., 2015; Saab, Van Joolingen & Van Hout-Wolters, 2012). Through these learning experiences, learners deepen their understanding of both science content and scientific thinking and methodologies (Edelson, Gordin & Pea, 1999). The basic idea of questioning, analyzing, and applying shows parallels to expansive learning according to Engeström (1987), as does team-based learning.

Learner-centered scaffolding has references to Vygotsky's concept of the "zone of proximal development"[69] (e.g., 1978) and was first introduced into the literature by Wood, Bruner, and Ross (1976). The teacher provides the learner with an individualized instructional scaffold that only provides support in those areas that exceed the learner's current knowledge and skill level (see, e.g., Orey, 2010, for an overview) - with the goal of being able to gradually dismantle the scaffold after learning successes ("fading" as it is called, Sonntag & Stegmaier, 2007, p. 81). Here, too, given problems can be solved by the learners, but less self-determined than in the previously described learning concepts.

3.4   Overview of the presented forms of learning

Of the twelve learning concepts presented in Chapters 3.3.1 to 3.3.12, eight can thus be regarded as independent, individual-oriented forms of learning. Together with informal learning as the ninth form of learning, these can be presented as an overview in a tree diagram (see Figure 5). Here, four dimensions are used as representation characteristics, on the basis of which the nine forms of learning can be distinguished particularly efficiently, i.e. using as few dimensions as possible[70] . Only transformational learning and informal learning require for the further delimitation of the three additional dimensions, since they resemble themselves in all four represented dimensions. On the basis of the tree diagram it is to be recognized fast, which of the learning forms on the lowest level closely together-stand and thus also contentwise more near are related.

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[69] The zone of proximal development according to Vygotsky represents the area in which a learning person can solve a task with assistance. The zone lies between the area in which she can solve the task alone (without help from teachers or peers) and the area that would represent an excessive demand even with help (Chaiklin, 2003).

[70] It cannot be ruled out that, when considering other potential forms of learning not taken up in this paper, a different combination of dimensions may prove more efficient.
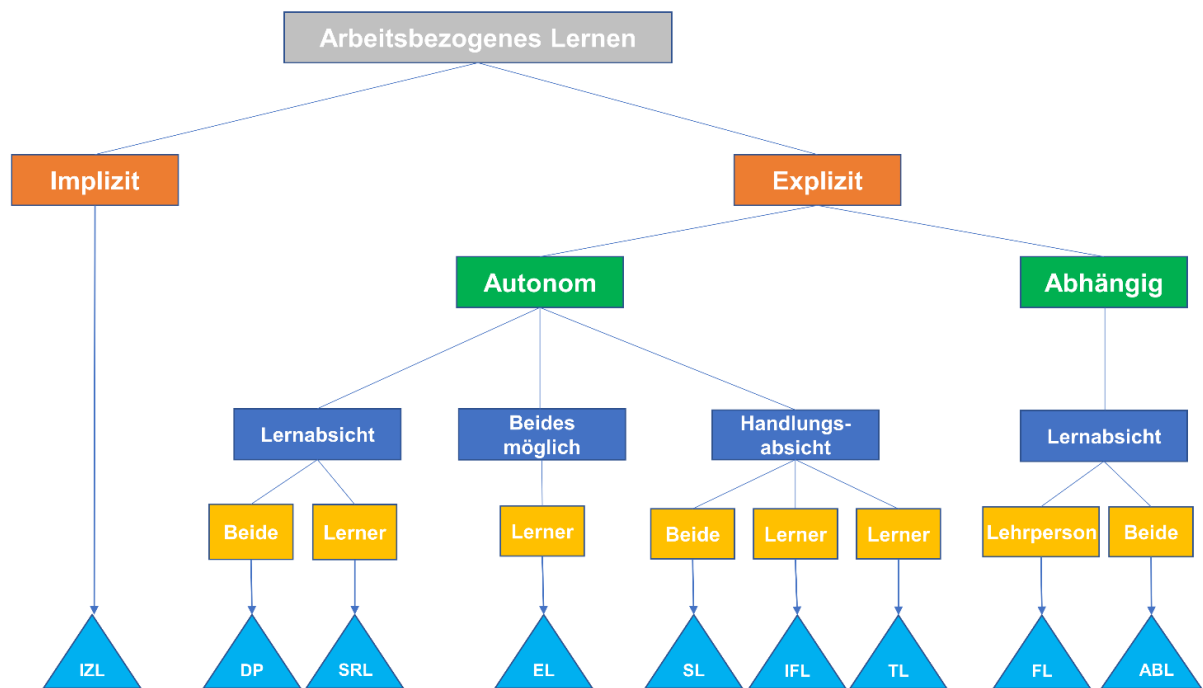
Figure 5: Tree diagram of the nine learning forms (shown in light blue) of work-based learning, based on the dimensions of "awareness" (orange), "structural specification" (green), "intentional orientation" (dark blue), and "learning process responsibility" (yellow); own illustration.

Notes: IZL = Incidental Learning, DP = Deliberate Practice, SRL = Self-Regulated Learning, EL = Experiential Learning, SL = Situated Learning, IFL = Informal Learning, TL = Transformational Learning, FL = Formal Learning, ABL = Work-Based Learning; own presentation.

Figure 6 also provides an overview of how the nine forms of learning are expressed on each of the seven dimensions - as explained in detail in Chapter 3.3.

Dimension	Linker Pol		Mitte		Rechter Pol	
Bewusstheit	*Implizit*	Nur inzidentelles Lernen			*Explizit*	Alle anderen Lernformen
Strukturvorgabe	*Unabhängig von vorgegebenen Strukturen (autonom)*	IFL, SRL, DP, EL, TL, SL, IZL			*Abhängig von vorgegebenen Strukturen*	FL, ABL
Intentionale Ausrichtung	*Handlungsabsicht (problemgebunden)*	IFL, TL, SL	*Beides möglich*	EL	*Lernabsicht (problemunabhängig)*	FL, SRL, DP, ABL
Lernprozessverantwortung	*Bei der lernenden Person*	IFL, SRL, EL, TL	*Bei beiden (gleichermaßen)*	DP, SL, ABL	*Bei der Lehrperson / Institution*	FL
Lernzeitpunkt	*Reaktiv (nahezu spontan)*	IFL, SL, IZL	*Beides möglich*	EL, TL	*Überlegt (deliberativ)*	FL, SRL, DP, ABL
Stimulus zur Zielfestlegung	*Internal*	SRL, DP, EL, TL			*External*	IFL, FL, SL, ABL
Lernsituation	*Arbeitsgebunden (direkt am Arbeitsplatz)*	IFL, TL, SL	*Beides möglich*	SRL, EL, ABL, IZL	*Arbeitsorientiert (außerhalb des Arbeitsplatzes)*	FL, DP

Figure 6: Overview of the expression of the nine forms of learning on each of the seven dimensions for classification; own illustration.

Notes: IZL = Incidental Learning, DP = Deliberate Practice, SRL = Self-Regulated Learning, EL = Experiential Learning, SL = Situated Learning, IFL = Informal Learning, TL = Transformational Learning, FL = Formal Learning, ABL = Work-Based Learning; own presentation. Incidental learning takes a separate role due to its incidental, implicit character and is not located on the following dimensions (cf. chapter 3.3.3): Intentional orientation (neither oriented towards a learning goal nor towards an action goal); learning process responsibility (neither with the teacher nor with the learner), stimulus for goal setting (since there is no goal orientation).

The delimitation of different forms of learning is primarily the subject of a theoretical-conceptual discourse. In order not to neglect the practical perspective, it seems to be useful to present examples of learning situations. Table 10 provides such an overview. Here, first of all, an example of foreign language acquisition is given for each form of learning, since such a learning situation is catchy and familiar to many people. Particularly relevant for the background of the present work are furthermore the partly more complex examples from the work context.

Table 10: Learning forms with examples of foreign language acquisition and from the work context

Lernformen	Beispiel für den Erwerb von Fremdsprachenkenntnissen	Beispiel aus dem Arbeitskontext
Informelles Lernen	Reise in ein fremdsprachiges Land, bei Verständigungsschwierigkeiten „learning by doing" anwenden (sprechen, bei Einheimischen nachfragen, eigenes Sprechen reflektieren)	Problemlösung im Arbeitsprozess: Problem tritt auf; es wird gelöst durch z. B. Ausprobieren, andere Personen fragen, Nachdenken; die Arbeit kann fortgesetzt werden
Formales Lernen	Sprachkurs belegen (z. B. an der Volkshochschule)	An einer Produktschulung teilnehmen
Inzidentelles Lernen	Radiosender in einer Fremdsprache läuft im Alltag im Hintergrund	Beiläufiges, unbewusstes Lernen während der Arbeitstätigkeit
Selbstreguliertes Lernen	Auslandsreise nach Lernzieleignung planen und eigenen Lernplan erstellen	Arbeitsrelevante Technik lernen mit selbst recherchiertem YouTube-Video und eigenen Lernzielen
Deliberate Practice	Schwierigkeit steigern, mit Muttersprachlerin bewusst über herausfordernde Themen sprechen (z. B. im Sprachtandem)	Computerprogrammierung mit immer höheren Komplexitätsniveaus
Erfahrungsorientiertes Lernen	Bisherige Spracherfahrungen bezüglich Stärken/Schwächen reflektieren, neues Lernkonzept für sich selbst überlegen und dieses anwenden	Fehleranalyse, Reflektion und angepasstes Handeln bei zukünftigen Aufgaben
Transformationales Lernen	Kritisches Ereignis ("disorienting dilemma") regt Lernprozess an: sich der Polizei im Ausland nicht verständlich machen können	Arbeitsunfall aus Unwissenheit führt zu kritischer Selbstreflexion
Situiertes Lernen	Spracherwerb in einer Gastfamilie	Person kommt neu in eine Arbeitsgruppe
Arbeitsbasiertes Lernen	Organisierte Sprachreise im Ausland, mit Betreuung und Unterstützung (z. B. für Studierende)	Praktikum/Hospitation

It should be noted that such an overview with short potential scenarios can only approach the theoretical depth of the learning forms presented to a certain extent. Moreover, as the term "example" already makes clear, only *one* possible manifestation of the respective learning form is presented, so that some features of the learning form are in the foreground, while other features take a back seat. This is often the case in practice as well, since the learning forms rarely occur in their ideal-typical form.

All nine forms of learning considered can also be grouped under the term "work-related learning", which also forms the highest level in the tree diagram (Figure 5) as a generic term.

Work-related learning as a conceptual unit comprises all learning activities that take place in the context of work (Poell, 2013, p. 21). It can thus take place both at work ("on the job") and outside the workplace ("off the job") (Kyndt & Baert, 2013, p. 275). Sambrook (2005) draws a narrower boundary line: in her view, only learning processes within the organization ("at work") and those embedded in the work process ("in work") are to be understood as work-related learning. It thus includes formal courses within the workplace in the definition, but not formal courses outside the workplace. However, this paper does not follow this view, as courses that take place outside the company can also be comparably work-related - for example, when an external trainer comes to a company and leads a course on site[71] . Furthermore, some research confines work-related learning to a dichotomy between informal and formal learning (Doornbos, Simons & Denessen, 2008; Gijbels, Raemdonck, Vervecken & Van Herck, 2012[72] ; Kyndt & Baert, 2013) . This paper does not follow this view either and uses the term in the broader understanding of Poell (2013).

The term workplace learning is also very present in the literature. However, the use of this term without further additions such as "formal" or "informal" is only recommended to a limited extent, as it is defined very diversely by many different authors (e.g. Bauer, Festner, Gruber, Harteis & Reid, 2004; Billett, 2002; Choi & Jacobs, 2011; Clairns & Stephenson, 2009; Eraut, 2004; Evans, Hodkinson, Rainbird & Unwin, 2006, p. 4; Fuller & Unwin, 2005; Garavan, Morley, Gunnigle & McGuire, 2002; Hicks, Bagg, Doyle & Young, 2007; Ifenthaler, 2018; Jacobs & Park, 2009; McCormack, 2000; Moon & Na, 2009; Poell & Woerkom, 2011; Verdonschot & Keursten, 2011; Watkins & Marsick, 1992; see Manuti et al., 2015, or Smith, 2003, or Tynjälä, 2013, each for an overview). Many of the definitions exclude formal learning, some include informal learning, and are more similar to the catchall term autonomous learning (Noe & Ellingson, 2017; Kraiger, 2017; see term "autonomous" in Figure 5). Some definitions describe workplace learning as a separate learning concept and focus on the learning process, while others focus on the learning outcome-a large number of studies even use the term without offering a definition at all. It can be concluded that the term - used on its own without an addendum - as a kind of "mixed category" contributes more to confusion than to clarification

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[71] However, Sambrook (2005) himself notes restrictively: "There is a potential overlap, for example, where external providers such as universities (offering opportunities for learning outside work) deliver formal corporate courses *at the* place of work" (p. 106).

[72] Interestingly, the authors in a similar composition (Gijbels, Raemdonck & Vervecken, 2010) in an earlier study use the term synonymously with informal learning ("learning from doing work itself," p. 240) in terms of content, without including formal learning in the concept.

of conceptualization (see Clarke, 2005, for a similar critical review). This paper will therefore refrain from using this term.

Having now distinguished informal learning from the other forms of learning and differentiated the forms of learning from each other, it is important to note that the forms of learning to be theoretically distinguished are rarely present in pure form in practice. In fact, it is not only possible but the rule that learning forms overlap and occur simultaneously together in a learning situation. This is discussed in research especially with regard to the connection of formal and informal learning (e.g. Rohs, 2007, p. 30). In this context, some criticize that the collaborative occurrence of these forms of learning is too often ignored in academic discourse (Colley et al., 2003; Mulder, 2013). Learning stations and quality circles are cited as examples of the integration of both forms of learning (Dehnbostel, 2008, p. 64), sometimes referred to as "structured on-the-job learning" (Jacobs, 2002). Segers et al. (2018, p. 8) also state that formal training programs are accompanied by informal learning activities (e.g., through discussions during break times), but informal learning activities can also lead to the need to participate in formal training programs (e.g. , when seeking feedback leads to identifying one's own competency gaps that can most efficiently be filled by participating in training). Similarly, Kahnwald (2018) notes that "even in formal contexts, learning is informal in the sense of the hidden curriculum (Zinnecker 1975)" (p. 344); that is, for example, sociali sation processes teach values, norms, and behaviors that have not been officially established as learning goals. Some research thus assumes that informal and formal learning can be viewed as two ends of a continuum (e.g., Sommerlad & Stern, 1999). This dichotomization may work in cases where only these two forms of learning are considered - but as soon as the variety of learning forms, as presented in this paper, is brought into focus in detail, classification problems arise with regard to the demarcation.

Another example of the simultaneous occurrence of several forms of learning with regard to self-regulated learning would be when the learner pursues his or her own learning goals during a formal training program - in addition to the officially specified learning goals - and monitors his or her own learning process as well as adapts it, if necessary, within the scope of the specified possibilities. Similar examples are conceivable for other forms of learning. Incidental learning also plays a special role: As already described in chapter 3.3.3, this form of learning can basically accompany every situation and action and occur as a kind of unconscious "background noise" combined with every other form of learning (see also Straka, 2004).

With this *caveat* in mind, that construct boundaries in work-based learning research are often blurred and more than one theoretically based solution is possible (cf. Malinen, 2000, p. 150), it is time - following the theoretical discourse that has taken place in Chapters 2 and 3 - to refocus on answering the research questions raised in Chapter 1.4. To this end, the

methodological structure of the three sub-studies mentioned at the beginning of this section will be explained and the central study results described below.

4. Partial studies of the cumulative dissertation

Three sub-studies were conducted as part of this research to answer the research questions raised in Chapter 1.4. Table 11 provides an overview of the objectives, the survey methodology, the procedure and the analysis process, as well as the results of the three sub-studies. The sub-studies are also described in more detail below.

Table 11: Overview of the three sub-studies of the research work.

	Targets	Survey methodology	Procedure and analysis process	Results
1	Development of a model to conceptualize informal learning; development of a measurement instrument to operationalize informal learning of industrial employees in SMEs; testing of the reliability and validity of the measurement instrument.	Twelve semi-standardized interviews with managers in SMEs; 15 "thinking out loud" interviews with semi-skilled and unskilled industrial employees; questionnaire survey with 546 (study A) and 349 (study B) industrial employees	Development of the octagon model based on the model of Tannenbaum et al. (2010); creation and testing of an item pool including the interview results; study A: reduction of the item pool based on an EFA (with the first half of the sample, N = 273) and a subsequent CFA (with the second half of the sample, N = 273); testing of reliability, convergent and discriminant validity, and criterion validity based on hypotheses about the relationships of informal learning with conscientiousness and learning outcomes; study B (N = 349): Comparison of competitive model structures using CFA; derivation of a short scale of informal learning and initial reliability testing.	Octagon model of informal learning; validated 24-item scale of infor meal learning; first approach to an 8-item short scale of informal learning.

	Targets	Survey methodology	Procedure and analysis process	Results
2	Development of a conceptual framework model of the antecedents and learning outcomes of informal learning among industry employees in SMEs; empirical testing of the relationships arising from the framework model.	Questionnaire survey with 702 industry employees	Development of the conceptual framework model based on the model from the meta-analysis by Cerasoli et al. (2018), taking into account the learning needs of industry employees and including an input-process-output perspective; theoretically and empirically justified derivation of eight hypotheses related to the framework model; simultaneous testing of these hypotheses by means of structure equation modeling based on the collected sample	APO Framework Model of Antecedents dencies and Learning outcomes of informal learning in the workplace; empirical support for seven of the eight Hypo theses.

| 3 | Simultaneous testing of the "active-learning hypothesis" and the "active-adaptation hypothesis" on the basis of the job-demand-control model; determination of the causal effect direction over time between work to demands and work control (decision latitude) on the one hand and informal learning on the other hand | Questionnaire survey with 129 industrial employees at two measurement points with a time interval of 1.5 years | Classification of the assumptions of the job demand control model in the context of informal learning in the workplace; empirical testing of the "active learning hypothesis" and the "active adaptation hypothesis" in a cross-lagged panel design using structure equation modeling | Empirical Support for the "Active Adaptation Hypothesis" in the Context of Infor mational Learning on the Job among Industrial Employees in SMEs |

Notes: APO framework model = "Antecedents, Processes, and Outcomes Framework of IWL for Blue-collar Workers"; CFA = confirmatory factor analysis; EFA = exploratory factor analysis; SME = small and medium-sized enterprises.

4.1 Substudy 1: Development of a measurement tool to operationalize informal learning in the workplace.

4.1.1 Objectives of the first sub-study

The goal of Substudy 1, or the first manuscript, "Informal Workplace Learning: Development and Validation of a Measure" (Decius et al., 2019) is to answer the following research question raised in Section 1.4:

How can informal learning in the workplace be conceptualized, i.e., presented as a concept that is as complete as possible, and operationalized, i.e., made measurable?

For this purpose, a model for the conceptualization of informal learning at the workplace was established on the basis of theoretical considerations, which was followed by the development of a measurement instru ments for the operationalization of informal learning of industrial employees in SMEs. The reliability and validity of this measurement instrument were then empirically tested. The methodological approach followed and the results of sub-study 1 are presented in the following as an overview.

4.1.2 Procedure and methodology of the first sub-study

Based on the dynamic model of informal learning by Tannenbaum et al. (2010; see Figure 2), the octagon model of informal learning in the workplace was developed, which represents the components of informal learning in more detail and thus allows for a more precise operationalization (see Chapter 2.3.3 for the detailed description of the model development; see Figure 3).

As a preparatory step for the development of the measurement instrument, twelve partially standardized interviews were conducted with managers in manufacturing SMEs. Among other things, they were asked what competencies semi-skilled and unskilled industrial employees need at work, what opportunities exist for acquiring these competencies through informal learning in the company, and in what way and with what frequency the employees take advantage of these opportunities. The goal was to obtain evidence from practice on how informal learning might be captured or measured-aware that this form of learning cannot be captured by traditional educational research indicators such as training hours, continuing education participation rates, financial expenditures, or skill levels attained (Skule, 2004, p. 10). Next, between four and seven items were developed for each of the eight components in the octagon model, resulting in a 40-item item pool. Regarding the wording of the items, methodological recommendations were considered (DeVellis, 2003; MacKenzie, Podsakoff & Podsakoff, 2011). In addition, the verb "to learn" was avoided as much as possible because it might evoke associations with formally organized and classroom-based learning and thus weaken the awareness of having learned something informally (Eraut, 2007).

In 15 interviews using the "thinking aloud" method (Flaherty, 1975; Willis, 2005) with a representative selection of industrial employees in SMEs, the items were validated in terms of content and checked for comprehensibility. Based on the interview results, minor changes were made to the item formulations, for example, simplifications and adjustments were made for items that were abstract or metaphorical in meaning. In addition, several scale formats were tested during the interviews. A four-point Likert scale with the evaluation anchors "Do not agree at all," "Somewhat disagree," "Somewhat agree," and "Fully agree" proved to be particularly suitable for the target group of industrial employees. The 40-item scale was then used in a questionnaire survey with 546 industrial employees in 21 German SMEs (study A). The sample was randomly divided into two halves.

With the first half, the item pool was reduced to 27 items with the help of an exploratory factor analysis (EFA) - with the theoretically justified specification of extracting eight factors - on the basis of the factor loadings. With the use of a subsequent confirmatory factor analysis (CFA) using the second half of the sample, a further reduction of the item pool was carried out to fulfill the quality criterion of test economy (cf. Döring and Bortz, 2016, p. 449), in which the

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item with the lowest factor loading was removed step by step until the model fit no longer improved significantly. This resulted in a final version of the measurement instrument with 24 items.

With the entire sample, the values for the reliability of the eight subscales as well as the convergent and discriminant validity were examined. In addition, eight previously established and theoretically derived hypotheses were tested, which were dedicated to the criterion validity of the measurement instrument. For this purpose, the correlations of informal learning with constructs from the nomological network of informal learning - on the one hand the personality trait conscientiousness, on the other hand four aspects of the learning outcome - competence increase, work flexibility, efficiency increase and stress reduction - were examined (see Table 12).

Table 12: Overview of the hypotheses from sub-study 1

Hypo-these	Komponenten des Oktagon-Modells	Kriterium	Angenommener Zusammenhang
H1	Eigenes Ausprobieren, Modelllernen	Gewissenhaftigkeit	Positiv
H2	Direktes Feedback, Stellvertretendes Feedback	Gewissenhaftigkeit	Negativ
H3	Vorausschauende Reflexion, Reflexion im Nachhinein	Gewissenhaftigkeit	Positiv
H4	Extrinsische Lernintention, Intrinsische Lernintention	Gewissenhaftigkeit	Positiv
H5	Eigenes Ausprobieren, Modelllernen	Lernergebnisse	Positiv
H6	Direktes Feedback, Stellvertretendes Feedback	Lernergebnisse	Positiv
H7	Vorausschauende Reflexion, Reflexion im Nachhinein	Lernergebnisse	Positiv
H8	Extrinsische Lernintention, Intrinsische Lernintention	Lernergebnisse	Positiv

Notes: Illustration based on Decius, Schaper & Seifert (2019, p. 503). Learning outcomes include increase in competence, work flexibility, increase in efficiency, and reduction in stress.

While a validated scale was used to operationalize conscientiousness (Körner et al., 2008), four scales were developed to capture the learning outcomes in the sub-study, which were also based on the aforementioned interview results with the managers. These twelve items (three items for each of the four learning outcomes) were also tested for comprehensibility within the target group using the "thinking aloud" method (Flaherty, 1975; Willis, 2005). Factor structure was examined using two independent CFAs with half 1 and half 2 of the total sample.

Subsequently, a further sample consisting of 349 industrial employees was surveyed in ten German SMEs (study B). Using another CFA, a comparison of competitive model structures was made on the basis of this sample. The following four alternative models were examined:

1. A 1-factor structure where all 24 items load on a general factor.

2. A 4-factor structure corresponding to the Tannenbaum et al. (2010) model, with six items loading on each of the four factors, and the four factors in turn loading on a general factor.

3. An 8-factor structure in which three items load on each of the eight factors of the Octagon model, and the eight factors in turn load on a general factor.

4. A 4x2 factor structure in which three items each load on one of the eight factors of the Octagon model, the two Octagon factors that are related in content each load on the parent factor from the Tannenbaum et al. (2010) model, and the four Tannenbaum factors in turn load on a general factor.

Model goodness of fit was determined using the Chi² value, Comparative Fit Index (CFI), Standardized Root Mean Square (SRMR), Root Mean Square Error of Approximation (RMSEA), Normed-Fit Index (NFI), Incremental Fit Index (IFI), and the Akaike Information Criterion (AIC) and Browne-Cudeck Criterion (BCC), which are particularly recommended for model comparisons (see Kline, 2016, for a review).

In addition, an eight-item short scale was developed. For this purpose, another EFA was conducted with the total sample from study A and the 24 items of the final version of the measurement instrument - with the specification to extract only one factor. Then, of the three items of each factor in the octagon model, the item with the highest factor loading was selected for the short scale to ensure complete coverage of all components of informal learning in terms of content. The reliability of the short scale was tested using the sample from Study B.

4.1.3 Results of the first sub-study

The examination of the reliability of the eight subscales of informal learning in investigation A (Cronbach's alpha between .76 and .88) and investigation B (Cronbach's alpha between .76 and .92) revealed satisfactory values for internal consistency. Regarding convergent validity, it was found that the values for the average extracted variance - calculated for each factor based on the latent factor loadings (cf. Fornell & Larcker, 1981) - were above .50 in both studies. With regard to discriminant validity, the values for the average extracted variance were found to be larger than the common variance between two factors in each case. Thus, both convergent and discriminant validity of the constructs can be assumed (cf. Farrell, 2010; Hair, Black, Babin & Anderson, 2010).

In order to test the validity of the criteria, the eight hypotheses were examined in study A by means of correlation analyses: Seven of the eight hypotheses could be confirmed; only the correlation between conscientiousness and feedback, which was assumed to be negative, could not be shown. Overall, the correlations between the eight factors of informal learning and conscientiousness ranged from $r = .05$ to $r = .38$. the four constructs of learning outcomes

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correlate with the eight factors of informal learning in the range between $r = .09$ and $r = .48$. The largest correlations are shown with the learning outcome *increase in competence*, and the lowest with the learning outcome *decrease in strain*. Overall, indications of the criterion validity of informal learning were found.

Comparison of the competitive model structures in Investigation B showed that the 1-factor structure had a very poor model fit, the 4-factor structure had a poor fit, and the 8-factor structure and the 4x2-factor structure[73] each had an acceptable to good fit. Furthermore, the calculation of Chi² tests showed that the 4x2 factor structure gave a significantly better model fit than the 8 factor structure[74] . Thus, the theoretically assumed two-layer structure of the octagon model could be empirically proven. The reliability of the 8-item short scale based on the data in Investigation B shows - despite the large heterogeneity in content of the items covering all eight factors of the Octagon Model - a remarkably high internal consistency (Cronbach's alpha = .79). The discriminatory power of the items of the short scale lies in the range between .34 and . 61.

Thus, the results of the first sub-study of this work are the octagon model of informal learning, a validated 24-item scale for operationalizing informal learning in the workplace (see Table 13), and a first approach of an 8-item short scale to be further validated in the future.

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[73] Values for model goodness of the final 4x2 factor structure: $\chi^2(240) = 545.3$, $p < .001$; CFI = .94, RMSEA = .06, SRMR = .06.

[74] Chi² test results: $\Delta\chi^2 = 75.0$, $\Delta df = 4$, $p < . 001$.

Table 13: Final 24 items of the scale for operationalizing informal learning at work among industrial employees in SMEs.

Komponente des Oktagon-Modells		Finale Itemformulierung
Eigenes Ausprobieren	1	Ich probiere bei neuen Aufgaben einfach eine andere Methode bei der Arbeit aus.
	2	Ich probiere bei neuen Aufgaben meine eigenen Ideen aus.
	3*	Ich setze meine eigenen Ideen zum Verbessern der Aufgaben bei der Arbeit ein.
Modelllernen	4*	Ich schaue, wie andere im Betrieb arbeiten, um meine Arbeit zu verbessern.
	5	Ich schaue mir an, wie meine Kollegen arbeiten, damit ich nicht die gleichen Fehler mache wie sie.
	6	Ich probiere Sachen bei meiner Arbeit aus, die ich mir bei meinen Kollegen abgeguckt habe.
Direktes Feedback	7	Ich frage meinen Vorarbeiter oder Chef, wie gut ich gearbeitet habe.
	8	Ich frage bei meinem Vorarbeiter oder Chef nach, wenn ich nicht sicher bin, wie gut ich gearbeitet habe.
	9*	Ich frage bei meinen Kollegen nach, wenn ich nicht sicher bin, wie gut ich gearbeitet habe.
Stellvertretendes Feedback	10	Ich frage meine Kollegen nach ihren Erfahrungen bei der Arbeit.
	11*	Ich frage meine Kollegen, welche Methoden und Tricks sie bei der Arbeit nutzen.
	12	Ich hole mir von meinen Kollegen Tipps und Hinweise zur Arbeit.
Vorausschauende Reflexion	13*	Vor einer neuen Aufgabe denke ich darüber nach, wie ich meine Arbeit am besten mache.
	14	Vor der Arbeit denke ich darüber nach, wie ich meinen Arbeitsplatz vorbereite.
	15	Vor einer neuen Aufgabe denke ich nach, auf welche Sachen ich bei der Aufgabe achten muss.
Reflexion im Nachhinein	16	Wenn ich mit einer neuen Aufgabe fertig bin, denke ich darüber nach, wie gut ich gearbeitet habe.
	17*	Wenn ich mit einer neuen Aufgabe fertig bin, denke ich darüber nach, was ich beim nächsten Mal noch besser machen könnte.
	18	Wenn ich mit einer neuen Aufgabe fertig bin, denke ich über die Qualität meiner Arbeit nach.
Extrinsische Lernintention	19*	Ich möchte für mich selbst bei der Arbeit etwas dazulernen, weil ich dann im Betrieb Karriere machen kann.
	20	Ich möchte für mich selbst etwas dazulernen, weil ich dann bei der Arbeit besser bin als meine Kollegen.
	21	Ich möchte für mich selbst bei der Arbeit etwas dazulernen, weil mein Vorarbeiter oder Chef dann beeindruckt von mir ist.
Intrinsische Lernintention	22	Ich möchte für mich selbst etwas dazulernen, weil ich dann mit Schwierigkeiten bei der Arbeit besser umgehen kann.
	23*	Ich möchte für mich selbst etwas dazulernen, weil ich dann Probleme bei der Arbeit schneller lösen kann.
	24	Ich möchte für mich selbst etwas dazulernen, weil ich dann auch bei schwierigen Aufgaben oder Anweisungen gut arbeiten kann.

Notes: Items selected for the short version of the scale are marked with asterisks (*). The short version of the scale was developed using the respective item with the highest factor loading within each component as part of an exploratory factor analysis (EFA). Validation of the short version is still pending. For reasons of linguistic complexity reduction, the original items only have the masculine form for the target group of industrial employees - for further practical use of the items in other target groups, however, a linguistic adjustment with regard to gender neutrality is recommended.

4.2 Substudy 2: An input-process-output model of the antecedents and learning outcomes of informal workplace learning.

4.2.1 Objectives of the second sub-study

The goal of Substudy 2, or the second manuscript, "Work Characteristics or Workers' Characteristics? An Input-Process-Output Perspective on Informal Workplace Learning of Blue-Collar Workers" (Decius et al., 2020[a]) is to answer the following research question raised in Section 1.4:

Which constructs are antecedents of informal learning in the workplace, i.e., precede and thus predict informal learning, and which constructs are outcomes of informal learning, i.e., follow from informal learning?

This generalized research question is broken down into three more specific questions in the manuscript:

1. Which antecedents have the highest associations with informal learning in the workplace?
2. Do personal or organizational antecedents matter more for informal learning in the workplace?
3. Which learning outcomes have the highest associations with informal learning in the workplace?

To answer these questions, a conceptual framework model of the antecedents and learning outcomes of informal learning among industrial employees in SMEs was developed and empirically tested along eight hypotheses. The procedure here and the results of sub-study 2 are presented in the following as an overview.

4.2.2 Procedure and methodology of the second sub-study

To simultaneously examine the antecedents and learning outcomes of informal learning, a holistic approach based on an input-process-output model was chosen (cf. Bushnell 1990; Ilgen, Hollenbeck, Johnson & Jundt, 2005). This model was linked to the performance perspectives approach (Sonnentag & Frese, 2002; Sonnentag, Volmer & Spychala, 2008). Here, the individual differences perspective and the situational differences perspective represent the input level, the performance regulation perspective represents the process level, and the adaptive performance perspective represents the output level. The general distinction between individual/personal and situational/organizational antecedents of workplace learning is widespread

in the literature at large (e.g., Baert, 2018; Cerasoli et al., 2018; Eraut & Hirsh, 2007; Tannenbaum et al., 2010).

Considering this basic division, the structural ordering grid from the meta-analysis of Cerasoli et al. (2018) was used as a basis to develop the conceptual framework model of the antecedents, processes, and learning outcomes of informal learning among industrial employees in SMEs (APO framework model). Following Cerasoli et al. (2018)[75] , the APO framework model consists of three levels of specification to rank the antecedents and learning outcomes (see Table 14).

Table 14 APO framework model of personal and organizational antecedents, processes, and outcomes of informal learning in the workplace.

Spezifikations-niveau 1	Spezifikations-niveau 2	Spezifikationsniveau 3	Zugeordnete Konstrukte
Personale Antezedenzien	Individuelle Prädisposition	Faktoren der Persönlichkeit/Bereitschaft	• Neugierde
		Allgemeine lernbezogene Motive	• Lernzielorientierung • Selbstgesteuertes-Lernen-Orientierung
Organisationale Antezedenzien	Arbeits-/Aufgaben-charakteristika	Arbeitsanforderungen/Ressourcen	• Zeitdruck
	Unterstützung	Unterstützung durch Personen	• Vorgesetztenunterstützung • Kollegiale Unterstützung
		Formelle/informelle organisatorische Unterstützung	• Fehlerbezogenes Lernklima
Lernergebnisse	Einstellungen		• Berufliche Involvierung
	Erwerb von Wissen/ Fertigkeiten		• Neu erworbene Kompetenzen
	Leistung		• Proaktives organisationales Verhalten (OCB)

Notes: OCB = Organizational citizenship behavior. The APO framework model was developed based on the model of Cerasoli et al. (2018). Illustration based on Decius, Schaper & Seifert (2020[a]).

Specification level 1 contains the rough subdivision into personal antecedents, organizational antecedents and learning outcomes. Specification levels 2 and 3 each contain a more detailed subdivision of the respective areas, whereby specification level 3 only occurs in the two areas of antecedents, but not in the learning outcomes. The right-hand column in the APO framework model also shows the constructs that were identified in the sub-study from a

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[75] The modification process in developing the APO framework model based on the meta-analysis by Cerasoli et al. (2018) is described in detail in the second manuscript (Decius et al., 2020[a]).

theoretical perspective as relevant for informal learning by industrial employees and were therefore included in the empirical study.

On the basis of the APO framework model, eight hypotheses could be derived regarding the connections of antecedents and learning outcomes with informal learning, the theoretical and empirical justification of which is presented in detail in the manuscript of the second sub-study (see Decius et al., 2020[a]). Table 15 shows an overview of the hypotheses raised.

Table 15: Overview of constructs and hypotheses in sub-study 2.

Nr.	Bereich	Konstrukt	Quelle der eingesetzten Skala	Hypothese
1	Pers. A.	Neugierde (Curiosity)	Kashdan et al., 2009	Neugierde hängt positiv zusammen mit informellem Lernen.
2	Pers. A.	Lernzielorientierung (Learning goal orientation)	VandeWalle, 1997	Lernzielorientierung hängt positiv zusammen mit informellem Lernen.
3	Pers. A.	Selbstgesteuertes-Lernen-Orientierung (Self-directed learning orientation)	Gijbels, Raemdonck & Vervecken, 2010	Die Orientierung, selbstgesteuert zu lernen, hängt positiv zusammen mit informellem Lernen.
4	Org. A.	Zeitdruck (Time pressure)	Richter et al., 2000	Zeitdruck hängt negativ zusammen mit informellem Lernen.
5	Org. A.	Soziale Unterstützung (Social support)	Putz, Schilling, Kluge & Stangenberg, 2013; Sonntag, Schaper & Friebe, 2005	Soziale Unterstützung hängt positiv zusammen mit informellem Lernen.
6	Lernerg.	Berufliche Involvierung (Job involvement)	Lodahl & Kejner, 1965	Informelles Lernen hängt positiv zusammen mit beruflicher Involvierung.
7	Lernerg.	Neu erworbene Kompetenzen (Newly acquired competencies)	Decius, Schaper & Seifert, 2019	Informelles Lernen hängt positiv zusammen mit neu erworbenen Kompetenzen.
8	Lernerg.	Proaktives organisationales Verhalten (Organizational citizenship behavior)	Williams & Anderson, 1991	Informelles Lernen hängt positiv zusammen mit proaktivem organisationalem Verhalten.

Notes: Pers. A. = Personal Antecedents; Org. A. = Organizational Antecedents; Lernerg. = Learning Outcomes; "Social Support" as a higher order construct is composed of the following three facets: Supervisor Support, Colleague Support, Error-Related Learning Climate.

A structural equation model was set up for simultaneous testing of the eight hypotheses. The data basis for the calculations was a sample of 702 industrial employees from 25 German SMEs. Established and validated scales were used to operationalize the constructs of the APO framework model (see Table 15; for more details, see Decius et al., 2020[a]). Informal learning

in the workplace was assessed using the 8-item Informal Learning Short Scale (Decius et al., 2019). English-language scales were translated into German using a translation-back-translation process (Brislin, 1986) . The comprehensibility of the items was tested on the basis of five interviews with industrial employees from the target group using the "thinking aloud" method (Flaherty, 1975; Willis, 2005). Based on the interview results, adjustments were made to six items (see in detail in Decius et al., 2020[a]).

To test for bias due to common method variance, Harman's one-factor test was used (cf. Podsakoff, MacKenzie, Lee & Podsakoff, 2003) and two models were calculated in which the items of the personal antecedents on the one hand and the organizational antecedents on the other hand each load on a common factor - ignoring the fact that the items belong to different constructs. If this results in a better model fit than if the items were correctly assigned to the respective constructs, this would indicate the presence of bias due to common method variance. The model fit was assessed using the following criteria recommended in the methodological literature: Chi² value, Comparative Fit Index (CFI), Standardized Root Mean Square (SRMR), Root Mean Square Error of Approximation (RMSEA). For the model comparisons, the Akaike Information Criterion (AIC) was also used (cf. Kline, 2016).

In order to check the robustness of the correlations, in addition to the holistic structural equation model - following methodological recommendations (Iacobucci, 2010; Weston & Gore, 2006) - two separate submodels were computed, one containing only antecedents and informal learning, the other containing only informal learning and learning outcomes. This approach was intended to account for the fact that evidence of mediation effects always requires a longitudinal research design (Mitchell & Maxwell, 2013). If the present cross-sectional design reveals similar relationships in the submodels (without mediation) and the overall model (with mediation), this would indicate the reliability of the overall model.

4.2.3 Results of the second sub-study

An examination of the reliability of the scales used revealed acceptable to good values of internal consistency (Cronbach's alpha between .74 and .93). The structural equation model had an acceptable model fit[76] despite its high complexity and large number of indicators. The calculations of the one-factor test and the two models representing the personal and organizational antecedents, each without construct structure, yielded poorer model fit values - thus there is no evidence for bias due to common method variance. The comparison of the two submodels with the overall model showed similarly large coefficients for the correlations between the constructs; only the construct social support had a significantly higher coefficient in the overall model compared to the antecedents submodel. Overall, it can thus be said that the

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[76] Model goodness of fit values: $\chi^2(1147) = 3142.504$, $p < .001$; CFI = .90, RMSEA = .05, SRMR = .06.

results of the overall model can be considered reliable despite the limitation due to the cross-sectional design.

When the hypotheses were tested on the basis of the results of the overall model (see Table 15), it was found that seven of the eight correlations were expressed in accordance with the hypotheses (see Figure 7). Only between time pressure and informal learning did a small but nevertheless significant positive relationship emerge - although a negative relationship had been hypothesized, as it was assumed that a lack of time resources impedes learning (cf. Cormier-MacBurnie, Doyle, Mombourquette & Young, 2015; Crouse, Doyle & Young, 2011; Hicks et al., 2007; Lohman, 2006). Time pressure thus appears to be at least somewhat condu-cive to informal learning. This assumption of the conduciveness of work demands to learning is considered in more detail in Substudy 3 (see Decius et al., 2020[b]).

The first question of sub-study 2, which antecedents show the highest correlations with informal learning at the workplace, can thus now be answered with a view to figure 7: The most significant antecedents are, in this order, self-directed learning orientation, social sup-port, curiosity, and learning goal orientation. The second question of sub-study 2, whether the personal or organizational antecedents have a greater significance for informal learning at the workplace, cannot be answered clearly. Except for the construct time pressure, all antecedents show roughly equal correlations with informal learning; the standardized coefficients (β) range from .24 to . 33. The answer to the third question of sub-study 2, which learning out-comes show the highest correlations with informal learning at work, is: The highest correlation was shown for proactive organizational citizenship behavior (β = .62), followed by newly ac-quired competencies (β = .55) as well as professional involvement (β = .44).

Thus, the results of the second sub-study of this thesis are the development of the APO framework model of the antecedents and learning outcomes of informal workplace learning for industrial employees in SMEs, as well as the result of an empirical test of the framework model and, concomitantly, an approach to answering the aforementioned three research ques-tions.
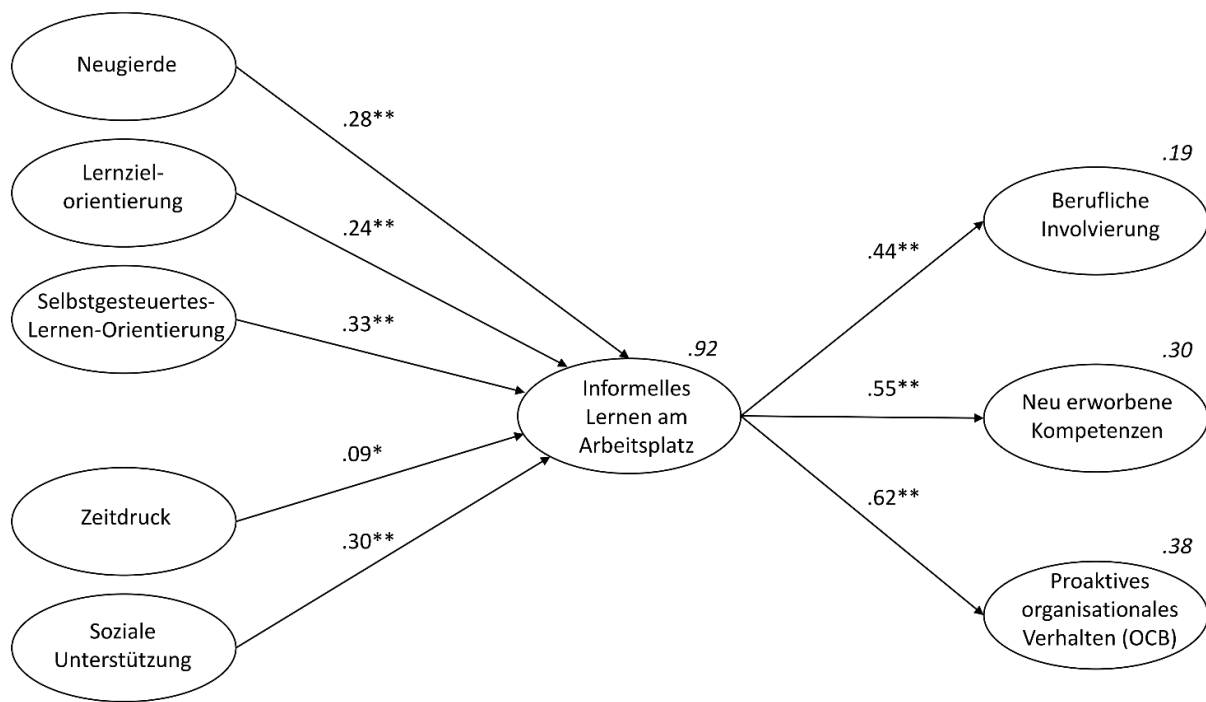
Figure 7: Results of the structural equation model (overall model) in sub-study 2.

Notes: Presentation based on Decius, Schaper & Seifert (2020[a]). The manifest indicators and residuals are not presented for clarity. Social support is a second-order construct consisting of the following three subconstructs (in clam mers the respective factor loading): supervisor support (.88), colleague support (.71), and error-related learning climate (.85). The explained variance (R^2) is reported for informal workplace learning and for the endogenous latent variables (learning outcomes).
* $p < .01$, ** $p < . 001$.

4.3 Sub-study 3: Longitudinal examination of the directions of action between informal learning and the working conditions.

4.3.1 Aims of the third sub-study

The goal of Substudy 3, or the third manuscript, "Do Job Demands and Job Control Lead to Informal Workplace Learning, or Vice Versa? A Cross-Lagged Panel Analysis" (Decius et al., 2020[b]) is to answer the following research question raised in Section 1.4:

What are the interactions between working conditions (exemplified by job demands and decision-making latitude) and informal learning in the workplace over time?

To answer this question, a longitudinal study with a time interval of 1.5 years was conducted. In this way, using a cross-lagged panel design in a structural equation model, it was possible to test whether working conditions lead to informal learning or whether informal learning influences working conditions. Based on the job demand control model, the former assumption is referred to as the "active learning hypothesis," and the latter assumption is

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referred to as the "active adaptation hypothesis" (see detailed description in section 1.4). Both hypotheses can be theoretically justified (e.g., De Lange et al., 2010; Taris & Kompier, 2004; Wielenga-Meijer et al., 2010; see Decius et al., 2020[b], for a review). The following is an overview of the methodological procedure and results of Substudy 3.

4.3.2   Procedure and methodology of the third sub-study

Since both the "active-learning hypothesis" and the "active-adaptation hypothesis" appeared to be possibly true, two hypotheses were formulated in the third sub-study, each with two sub-items, relating to job demands as well as decision latitude ("job control"):

- Hypothesis 1a: There is a positive effect over time of work demands on informal learning at work.
- Hypothesis 1b: There is a positive effect over time of decision latitude on informal learning in the workplace.
- Hypothesis 2a: There is a positive effect over time of informal workplace learning on job demands.
- Hypothesis 2b: There is a positive effect over time of informal workplace learning on decision latitude.

For the questionnaire survey, 349 industrial employees from ten German SMEs were recruited at the first measurement point. At the second measurement point after 1.5 years, 245 employees took part in the survey. Related to the adjusted data set, 129 employees could be assigned to both surveys via an anonymous person code and thus formed the sample for sub-study 3. Informal learning at work was surveyed using the 24-item informal learning scale developed in sub-study 1, which consists of eight subscales (Decius et al., 2019). Job demands and decision latitude were operationalized with three items each from Richter et al. (2000). In a preparatory step, to reduce complexity in the structural equation model while still taking into account the structure of the octagon model, the 24 items of informal learning were modeled as latent indicators and four factor scores were calculated (for experience/action, feedback, reflection, and learning intention). These factor scores were used in the cross-lagged panel model as indicators of informal learning.

Prior to further calculations, configural as well as metric measurement invariance[77] was checked, which must be present as a prerequisite for conducting a cross-lagged panel analysis (Lang, Bliese, Lang & Adler, 2011; Vandenberg & Lance, 2000). In accordance with

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[77] If the configural measurement invariance criterion is met, the structure of the latent constructs and indicators in the structural equation model is identical between both measurement time points; moreover, if the metric measurement invariance criterion is met, there are no significant differences between the factor loadings of the indicators on the latent constructs with respect to both measurement time points (cf. Kline, 2016, pp. 396-397).

methodological recommendations (Zapf, Dormann & Frese, 1996) and indications from applied literature regarding cross-lagged panel designs (Eby, Butts, Hoffman & Sauer, 2015; Lang et al., 2011), three models were calculated: Informal learning and decision latitude (Model 1); Informal learning and job demands (Model 2); Informal learning, decision latitude, and job demands (Model 3). The measurement errors of the same items at measurement time point 1 and measurement time point 2 were assumed to covary, following methodological indications (see Newsom, 2015). In addition to the Chi² value, the following global model fit criteria recommended by Kline (2016, p. 269) were used to assess the model quality: Comparative Fit Index (CFI), Standardized Root Mean Square (SRMR), Root Mean Square Error of Approximation (RMSEA).

4.3.3 Results of the third sub-study

Examination of measurement invariance for the three constructs considered (informal learning, job demands, decision latitude) revealed that the models with the specification of the same factor structure had a good model fit at both measurement time 1 and measurement time 2. This speaks for configural invariance. Moreover, fixing the factor loadings[78] across both measurement time points did not result in any change in significance of the Chi² value, so that metric invariance can also be assumed (cf. Little, Preacher, Selig & Card, 2007; Vandenberg & Lance, 2000). The prerequisites for the calculation of the cross-lagged panel model are thus given.

The analysis of the separate cross-lagged panel models (models 1 and 2) revealed very similar cross-lagged coefficients as in the more complex overall model (model 3). Therefore , the overall model, which simultaneously includes work requirements as well as decision space in addition to informal learning, was considered for testing the hypotheses (see Figure 8). The model showed satisfactory model fit, $\chi^2(147) = 223.62$, $p < .001$; CFI = .93, RMSEA = .06, SRMR = .08. Stability values between the constructs at the first and second measurement time points over the 1.5-year period are at a high level (between .51 and .64), indicating valid measurement of the constructs. Consideration of the cross-lagged effects shows that informal learning over time leads to both job demands (β = . 30) and decision latitude (β = .29)-but conversely, these two work conditions do not lead to informal learning. Hypotheses 2a and 2b could thus be confirmed, while hypotheses 1a and 1b had to be rejected.

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[78] This means that the computation defaults to estimating the factor loadings as identical in both models.
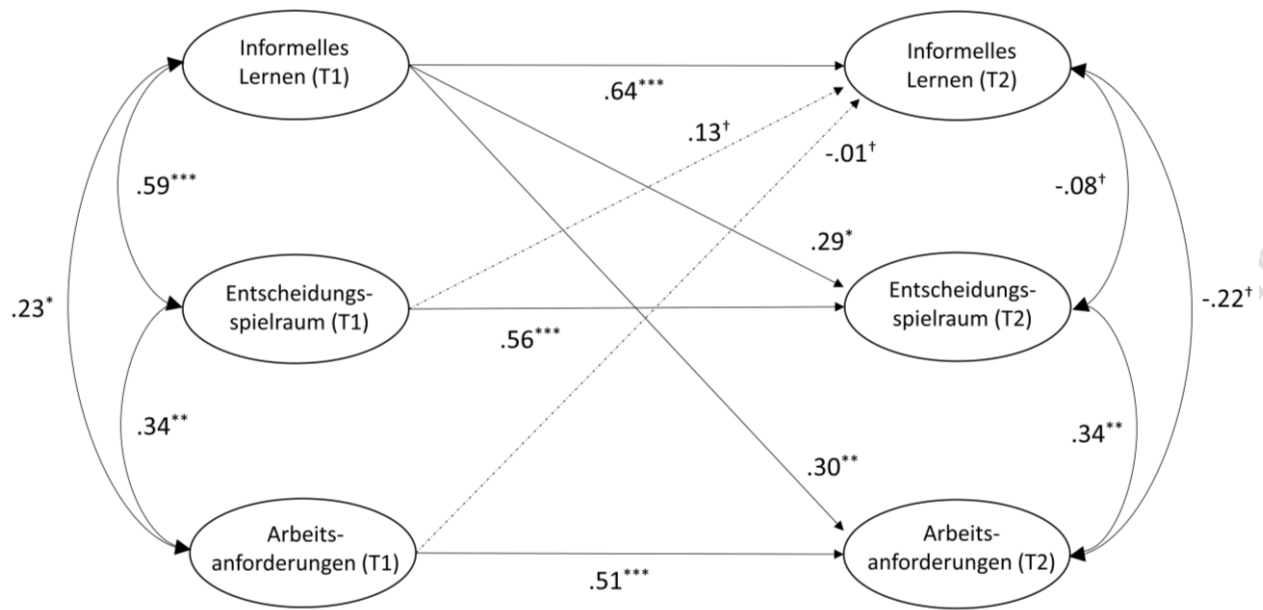
Figure 8: Results of cross-lagged panel calculations in substudy 3.

Notes: Illustration based on Decius, Schaper & Seifert (2020[b]). The values presented are standardized parameter estimators within the structural equation model. For clarity, the manifest indicators, factor loadings, error variances of the items and corresponding correlations, and at time point 2 the error terms are not shown. T1 = time 1, T2 = time 2.
*p < .05, **p < .01, ***p < .001, † = not significant.

Surprisingly, at measurement time 2, negative, albeit non-significant, correlations were found between informal learning and the work requirements as well as the scope for decision-making (cf. Figure 8) - although the corresponding correlations at measurement time 1 were significantly positive. Theoretically, this discrepancy is difficult to explain. However, from a methodological perspective, this finding might suggest that one or more mediator variables (e.g., job crafting; see Zhang & Parker, 2019, for an overview) play a role in the background of the relationship between informal learning and work characteristics that have so far been ignored in the model[79].

Thus, as results of the third sub-study of this thesis, empirical evidence is available for the "active-adaptation hypothesis" in the context of informal learning at work among industrial employees in SMEs, while the "active-learning hypothesis", which has been predominant in the literature so far, did not find support. The results can be aligned with findings from

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[79] In order to test this assumption, an additional longitudinal data collection with three measurement points at intervals of two weeks each is currently being conducted. The results of this supplementary investigation will be included in the manuscript before the final publication of the third sub-study in order to further strengthen the sub-study methodologically and conceptually. Due to the shorter time intervals, weaker cross-lagged effects are to be expected - but by including the mediator variable job crafting, the previously only theoretically assumed correlations can be empirically examined in this context and an explanation for the surprising correlations at measurement time 2 can possibly be found.

Eraut's (2011) qualitative study, which examined the content of informal learning in the healthcare sector. Here, it was found that the main changes that occurred as a result of informal learning were taking on greater responsibility, increasing their own skills, and dealing with more difficult and complex problems. These aspects can be referred to as job-crafting processes within the framework of Wrzesniewski and Dutton's (2001) theory.

5. Discussion

5.1 Summary of the partial studies

In the three sub-studies, this work is dedicated to the complex topic of informal learning at work with a focus on industrial employees in SMEs. In this way, the work tries to provide another small building block for giving an answer - to the comprehensive question "about the life [and learning of employees at work], the universe [of learning through and during work] and everything" (Adams, 1981, p. 164)[80] .

At the beginning, the challenge was how to define informal learning in the workplace and how to conceptualize it. This first step was taken with the development of the Octagon Model (Substudy 1). Furthermore, it should be possible to operationalize informal learning at the workplace in order to create a starting point to be able to conduct empirical studies on informal learning and to provide practice with an instrument to identify informal learning within the company. It was important to note that an appropriate measurement instrument should meet the requirements of the target group of industrial employees in SMEs and capture informal learning in a context-specific manner. This requirement was achieved through the development of the 24-item measurement instrument and the 8-item short scale (sub-study 1).

Following the conceptualization and operationalization of informal learning, the focus was on the question of which constructs are related to informal learning at the workplace among industrial employees in SMEs (sub-study 2). The background was that by identifying antecedents of informal learning in the workplace, possible approaches to support opportunities to promote learning could emerge. By identifying learning outcomes of informal learning, the aim was to work out which positive effects for SMEs could be expected from informal learning of employees. In addition, the identification of antecedents and learning outcomes should pave the way for a comprehensive theory to explain the mechanisms of action and processes of informal learning, the development of which future research can address. To this

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[80] Future research could be devoted to a more precise formulation of the question, if the Vogons do not know how to prevent it once again.

end, the APO framework model of antecedents, processes, and learning outcomes of informal learning can contribute (Substudy 2).

Two constructs that have often been described as antecedents of informal learning should then be examined more closely in a longitudinal context to explore in more detail the mechanisms of action related to informal learning over time: Work demands and decision latitude. Unlike other constructs, the hypothesized relationship between these work conditions and (informal) learning can be derived from an established theory, the job demand-control model (Karasek, 1979), which may be one reason for the large amount of research on this topic. Whether the "active learning hypothesis" stemming from the aforementioned model also applies to industrial employees in SMEs, or whether the alternative "active adaptation hypothesis" gains empirical support, should be tested as a conclusion of this research (Substudy 3).

What contribution have the three sub-studies now made to research and practice? Substudy 1 was able to show that informal learning at the workplace consists of eight sub-factors and can be reliably and validly operationalized in the context of industrial employees in SMEs with three items per sub-factor. Substudy 2 was able to show that both personal and organizational constructs are related to informal learning as antecedents; here, the self-directed learning orientation in particular should be mentioned as a particularly important factor. This gives rise to connecting factors for opportunities to promote informal learning. In addition, SMEs can expect positive effects on employees when they learn informally, namely with proactive organizational behavior, newly acquired competencies and professional involvement. Finally, sub-study 3 was able to show that - contrary to previous literature - work demands and decision-making scope cannot necessarily be regarded as antecedents of informal learning among industrial employees in SMEs. On the contrary - informal learning leads to a stronger expression of these two working conditions. This could be explained by job crafting processes triggered by learning. The surprising result could also explain why time pressure (to be seen as a work demand) showed only a very low correlation with informal learning in sub-study 2 (β = .09).

By combining the three sub-studies, this paper provides a valid insight into informal workplace learning among industrial employees in SMEs. In the following, the strengths, but also the limitations of this combined research approach will be explained.

5.2 Strengths and limitations

The strengths of the present work refer on the one hand to the combination of different perspectives, and on the other hand to the combination of different methodological approaches.

Particularly noteworthy is the theoretically grounded perspective, which was taken into account in all three sub-studies by referring to the international state of research on informal learning in the workplace. In doing so, two research traditions that have been predominant in the last decade are integrated. On the one hand, there is research from the "American school," rooted in organizational psychology and management research. Examples include Christopher P. Cerasoli, Kurt Kraiger, John E. Mathieu, John W. Michel, Raymond A. Noe, Karin A. Orvis, Eduardo Salas, Scott I. Tannenbaum, Michael J. Tews, and Mikhail A. Wolfson. The representatives of the "American school" particularly base their research on established psychological theories as well as on models of informal learning. For example, the approaches of Marsick and Watkins as well as the dynamic model of informal learning play an important role in their research. They conducted a significant part of their studies in the recent past with workers from management or military. With regard to the understanding of learning, the representatives assume a strongly problem-induced and intentional learning in informal learning - the focus is on learning behavior.

On the other hand, there is research from the "Belgian-Dutch school", which has its origins in pedagogy, especially in further bil dungs for schung. Examples include Herman Baert, Simon Beausaert, Filip Dochy, David Gijbels, Natalie Govaerts, Eva Kyndt, Irina Nikolova, Isabel Raemdonck, Mien Segers, Piet Van den Bossche, and Joris Van Ruysseveldt. The representatives of the "Belgian-Dutch school" often combine qualitative and quantitative studies designs, take a more inductive approach and collect empirical samples mainly in social occupational fields. The qualitative-case-oriented approach primarily yields insights into the ways in which specific occupational groups learn informally in the workplace. The understanding of learning with regard to informal learning is predominantly defined in distinction to formal learning and partly also includes non-intentional aspects - the learning context is in focus.

Before informal learning became more and more prominent as a research topic, both schools were dedicated to formal learning. Another difference here is that the representatives of the "American school" were mainly active in training (transfer) research before their engagement with informal learning, while the representatives of the "Belgian-Dutch school" were particularly concerned with initial vocational training (e.g. apprenticeship programs) of junior employees.

This paper integrates both schools of thought by drawing on the theoretical strength of the "American school" for conceptualization. For example, Tannenbaum et al.'s (2010) model served as the basis for developing the Octagon model of informal learning. Thus, this work, particularly Substudy 1, follows the understanding of informal learning as intentional learning behavior. It also draws on the strength of the "Belgian-Dutch School" in also looking more closely at the learning context through detailed - including qualitative - studies of the learning content and especially the antecedents and outcomes of informal learning. Substudy 2 and, to

some extent, Substudy 3 are based on this preliminary qualitative and quantitative work, some of which is very detailed, although the framing framework (the APO framework in Substudy 2) is again based on the meta-analysis of Cerasoli et al. (2018) and thus on representatives of the "American school." In contrast, the majority of previous studies on learning with reference to the job-demand-control model, which provides the conceptual foundation for Substudy 3, come from the "Belgian-Dutch school." Longitudinal considerations (as in sub-study 3) and statistically elaborate analyses are predominantly found in research from the "American school." In contrast, the delimitation of learning forms in the present research work (see chapter 3) follows the pedagogical-conceptual understanding of the "Belgian-Dutch school", which, for example, regards self-regulated learning as a separate form of learning, whereas in the "American school" this form of learning is partly mixed with informal learning.

In addition to this integration of the schools of thought from the theoretical perspective, the present work also includes the practical perspective in its consideration. While science in general is often accused of remaining in its "ivory tower" and shying away from contact with practice, great importance was attached to dovetailing with the practical experiences of SMEs[81] when developing the sub-studies. For example, the results of interviews with managers in SMEs were included in the development of the octagon model in sub-study 1, and the measuring instrument for operationalizing informal learning using the "thinking out loud" method was tested with industrial employees and its content validated. For the items of the questionnaire used in sub-study 2, the comprehensibility of the formulations was also tested in advance with employees of the target group; the items for work requirements and scope for decision-making for sub-study 3 were also already taken into account.

Apart from this pre-planned procedure, implicit insights into work processes and informal workplace learning in SMEs were gained in the course of SME acquisition, on-site data collection, presentation of evaluated results, and consultation with managers in SMEs, which were incorporated into the development of the sub-studies. This is equally true for the two-

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[81] This was done in particular within the framework of the joint research project StraKosphere ("Strategic competence management in non-research-intensive SMEs in the manufacturing sector") funded by the German Federal Ministry of Education and Research, which investigated the possibilities and conditions for success of competence development among semi-skilled and unskilled industrial employees through the collaboration of four manufacturing SMEs and three research partners from 2014 to 2017 (cf. Decius & Schaper, 2020; Horvat, Schaper, Virgillito & Decius, 2018).

week *covert participant observation*[82] (see Sonntag, Frieling & Stegmaier, 2012, pp. 112-119, for an overview of this field research method; see also Hermann, 1999; Lüders, 2011; Schöne, 2005) conducted by the author of this research in a metalworking company.

In addition to the inclusion of both theoretical and practical perspectives, the methodological diversity realized in the three sub-studies also represents a strength of the present work. A multimethod approach is applied across the sub-studies. Qualitative approaches, such as interviews with managers and industrial employees, were used to develop the octagon model and the measurement instrument for operationalizing informal learning in sub-study 1 and to validate the items used in sub-studies 2 and 3. However, the methodological focus of this work is on the collection and analysis of quantitative data. The analysis was predominantly conducted using structural equation modeling - a modern and powerful tool from the statistical toolbox (cf. Kline, 2016). Substudy 3, in particular, features a robust research design: Empirical data were collected at two measurement time points, and longitudinal data analysis was conducted using a cross-lagged panel design, which combines the advantages of correlational and experimental methods and allows for causal inference (Tyagi & Singh, 2014; Zapf et al., 1996). This responds to the growing call for longitudinal studies in the informal learning literature (e.g., Noe et al., 2014; Cerasoli et al., 2018).

Another strength is that the cumulative empirical basis of the three sub-studies is quite comprehensive: The evaluations are based on the information provided by 1726 participants[83] . This is a remarkable number, since it should be noted that there are a number of hurdles to overcome in the (time-intensive) acquisition of participants from industrial employees in SMEs. There are often reservations about scientific questionnaire surveys both on the part of employees or the works council (partly due to data protection concerns, partly due to

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[82] During a two-week "internship" in January 2019, the author worked as an unskilled employee in the CNC machine operation, assembly, and quality control departments of an SME specializing in aluminum processing (approx. 200 employees) - one week on the early shift, one week on the late shift. The focus and scientific interest were on self-monitoring of informal learning processes during the work; therefore, the author filled out a learning diary structured according to the eight categories of the Octagon Model at the end of each shift. Even though a scientist certainly learns informally in a different way than regular employees during a two-week observation period, the principle applicability of the Octagon Model for informal learning in an industrial context in SMEs could be confirmed. The analysis of the learning diary shows that a total of 106 behavioral and cognitive learning events were reported during the ten working days. Of these, 17% were in the octagon model category of "own trial and error," 18% were in "model learning," 29% were in "direct feedback," 13% were in "vicarious feedback," 10% were in "anticipatory reflection," and 12% were in "reflection after the fact." In addition, a learning intention was perceived 19 times, of which 53% corresponded to an "intrinsic learning intention," and 47% to an "extrinsic learning intention."

[83] Substudy 1: 546 subjects (Study A) and 349 subjects (Study B); Substudy 2: 702 subjects; Substudy 3: 129 subjects (who participated in both measurement time points).

skepticism about the benefits of the survey[84]) and on the part of management (with regard to the cost-benefit ratio of the time invested in having questionnaires filled out in relation to the expected results report). Since only very few industrial employees have access to a computer work place and often do not have a work e-mail address, the issue of paper questionnaires is the only survey option. However, unlike office workers, many employees in this field are not accustomed to reading and writing regularly during working hours, so that lengthy questionnaires can lead to fatigue[85] . As a consequence, many people do not even participate in a questionnaire survey. This trend has been reinforced in recent years by the mental risk assessment - which is mandatory by law for most companies - and which is also often carried out by means of written surveys. These reasons led to overall low to medium response rates of between 29 and 49%.[86] It is also noticeable that the proportion of female employees among the survey participants is low (22.7 % to 35.7 %).[87] However, this does not necessarily imply limited informative value, as this gender distribution represents the reality in the manufacturing sector. - However, any assumptions and extrapolations of the study results to industries or trades in which women are predominantly employed should be made with caution.

A limitation of the sub-studies in this thesis is that with regard to survey participation, there was very likely a certain degree of self-selection by the employees, as is common in voluntary surveys (cf. Heckman, 1990). Presumably, especially persons with a high motivation to work and those who were proficient in the German language and could read participated in the survey. Due to the prevailing work requirements to perform rather simple and repetitive (manual) work activities, these characteristics are less common among semi-skilled and unskilled industrial employees in SMEs than in work areas with higher requirements (cf. Ittermann et al., 2011; Virgillito, 2018). This could be a limitation for the representativeness of the survey results. On the positive side, however, it should be noted that due to the voluntary nature of the survey, the majority of participants took the completion of the questionnaire very

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[84] An attitude of "learned helplessness" (cf. Maier & Seligman, 1976) often prevails among the workforce, since previous surveys apparently did not lead to noticeable improvements in working conditions. In discussions with works councils, statements can be heard such as "It won't do any good anyway, nothing will change."

[85] HR managers in SMEs frequently referred to what they perceived to be "survey fatigue" among the workforce in the event of rejections during the acquisition process.

[86] Substudy 1: 49% (Study A) and 42% (Study B); Substudy 2: 38%; Substudy 3: 40% at measurement time 1 and 29% at measurement time 2.

[87] Substudy 1: 22.7% (Study A) and 29.0% (Study B); Substudy 2: 25.2%; Substudy 3: 35.7%.

seriously, as confirmed by the HR managers and representatives of the works councils who supervised the surveys.[88]

Sub-study 1 also has the limitation that a four-point Likert scale was used in the survey. The reason for this was that the interviewees from the target group in the pretests considered the scale with four gradations to be particularly comprehensible. However, this assessment was revised by the pretests in the run-up to sub-study 2, after the results of further interviews indicated that a six-point scale with meaningful rating anchors would lead to similarly good comprehension. The possible disadvantage of a Likert scale with only four gradations is an artificial variance restriction, insofar as the survey participants have to choose one of the four levels, although the true expression could be located between two levels (DeVellis, 2003, p. 75). This is true in principle for most questionnaire surveys - as long as no continuum is used for the classification, which, however, is much more difficult to evaluate in paper question-naires than in computer-based surveys. However, the proportion of participants who placed a cross between two rating levels, at least in individual cases, was conspicuously high.[89] For this reason, a six-point Likert scale was used in both sub-studies 2 and 3. This is also recom-mended for future studies when surveying industrial employees in SMEs.

Substudy 2 has the methodological limitation that a mediation model was constructed but evaluated in a cross-sectional research design. Mitchell and Maxwell (2013) point out that it is understandable that researchers evaluate mediation models cross-sectionally for practical and test economy considerations-but they also emphasize that longitudinal designs are more appropriate in this case (pp. 308-309; see also Maxwell & Cole, 2007, and Stone-Romero & Ro-sopa, 2008). Thus, as mentioned several times in the manuscript of Substudy 2, it is not possible to draw conclusions about causality - thus, the evaluation of the role of the considered con-structs as antecedents or learning outcomes of informal learning had to be done primarily through conceptual derivations.

Substudy 3, on the other hand, is based on such a methodologically more robust longi-tudinal research design. One limitation of this sub-study is the relatively small sample size (N = 129). Although 349 industrial employees took part in the survey at the first time point and 245 at the second time point, only 129 of them could be identified as having completed both questionnaires on the basis of the anonymous person code used. One reason for this is

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[88] In some cases, it was reported that some participants spent up to 45 minutes filling out a question-naire and only put their cross after a detailed reception of the respective question. This could also be due to the fact that most SMEs allowed the questionnaire to be completed during working hours. In any case, a positive effect on data quality can be expected.

[89] These classifications in the questionnaire had to be evaluated as missing values. Nevertheless, the proportion of missing values in sub-study 1 was still at an acceptable level (4.4% in study A; 2.8% in study B).

presumably the comparatively long interval of 1.5 years between the surveys. In some SMEs, there was a high level of fluctuation during this period due to economic and operational factors, so that in some cases it was not possible to survey the same employees a second time. It also cannot be ruled out that some employees may not have filled in the personal code truthfully for at least one of the two questionnaires due to data protection concerns[90] . Although there are no reliable indications of this, it is generally difficult to establish due to the anonymity function of the code. Even though these concerns should not be disregarded when evaluating the study results, a multivariate analysis of variance with regard to the item means of the variables used in the study showed that *dropout* between the measurement time points was not selective (cf. Decius et al., 2020[b]).

Another limitation in sub-study 3 is the negative (albeit non-significant) correlations between informal learning and job characteristics at the second measurement time point, which are difficult to explain conceptually and differ significantly from the corresponding correlations at the first measurement time point. As presented in section 4.3.3, this could indicate a mediator (e.g., job crafting) that has not been included in the model so far, which will be examined in a supplementary longitudinal study whose data collection is currently underway (cf. corresponding footnote in section 4.3.3). Moreover, in contrast to the third sub-study, whose participants were acquired through collaboration with SMEs, the participants in the supplementary survey are addressed directly, so it is unlikely that a large number of people come from the same organization. This minimizes the influence of hierarchically structured data ("nested data").

In principle, a more level design could be used in structural equation modeling to control for this effect if hierarchically structured data were available - but this is hardly possible with a data set like the one in sub-study 3. The reason for this is that some of the participating SMEs have very few employees, of whom in turn only a small number participated in the survey. As a result, only one to three participants can be assigned to some companies in the data set. This

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[90] The assignment code used was based on the recommendations of Pöge (2005, 2008, 2011) and was also piloted with employees from the target group during the pretest interviews and was considered to be in line with data protection requirements by the representatives of the works councils in the SMEs who were involved. The code comprised the following four criteria, which were assumed to be personal and constant over the survey period: "The **1st** letter from **your mother's** (first) first name or someone who was like a mother to you"; "The **1st** letter from your **father's** (first) first name or someone who was like a father to you"; "The **1st** letter from your **place of birth**, as it is called in your native language"; "In which **month is your** birthday?"; "The **1st** letter from your **place of birth, as it is** called in your native language". " Boxes containing the 26 letters of the German alphabet plus the three umlauts were given for the information on the first three statements. To answer the question about the birthday, boxes with the twelve months were given.

falls short of the minimum class size of 20 to 30 participants for a More levels analysis[91] (McNeish & Stapleton, 2016). Thus, the supplemental study currently being conducted will also be able to compensate for this methodological limitation of Substudy 3.

Overall, the review of the three sub-studies shows that the present work is based on a robust research design that combines the strengths of different approaches from qualitative and quantitative research, takes into account practical and theoretical perspectives, and integrates different schools of thought regarding informal learning in the workplace. In this way, individual limitations of the partial studies are compensated by the holistic approach.

5.3   Theoretical implications and research desiderata

As a result of sub-study 1, the octagon model provides research with a way of conceptualizing and the measurement instrument developed with a way of operationalizing informal learning at the workplace among industrial employees in SMEs. Thus, a contribution could be made to give more consideration to informal learning processes in this group of employees, which had previously received little attention from the scientific community, in the specialist literature. In a next step, the scientific focus should now be directed to the extent to which these results can be transferred to other target groups. Since informal learning must always be considered and interpreted in the context of the respective work situation and learning environment (Ellinger, 2005; Manuti et al., 2015), a qualitative pretest on the applicability and comprehensibility of the questionnaire items should precede a validation in other industries if possible. In this way, target group-specific differences with regard to informal learning can be recorded in advance and the formulations of the scale adapted accordingly if necessary. Validation would be recommended, for example, for office workers, managers, specific industries, and target groups with high continuing education needs (e.g., physicians) - but also for students in universities (whose "profession" is studying) who are involved in predominantly formal educational structures. For the latter target group, the focus could be on those aspects of "work" that arise from practical challenges and problems to be solved in the course of studies

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[91] According to McNeish and Stapleton (2016), fewer participants per "class" (e.g., companies) can only be the case if the number of classes is very large, i.e., > 100, for example. If there are fewer than ten classes, it is rather inadvisable to conduct a multilevel analysis, although the biasing effects can be reduced by using robust estimation methods (mentioned are Restricted Maximum Likelihood Estimation, Kenward-Roger Adjustment, and Bayesian MCMC) (see also Austin, 2010).

(i.e. , that the problems set by teachers in the context of a formal course, which are intended to serve a targeted learning purpose, are thus excluded)[92] .

The 8-item short scale of informal learning at the workplace should also be further validated in different contexts and target groups. This could also address the question of whether the selection of the eight items (one item per component of the octagon model) adequately depicts informal learning outside the target group of industrial employees in SMEs[93] . Also with regard to the construct validity of the scale within this target group, it could be further investigated whether the short scale correlates to a comparable degree with various constructs from the nomological network of informal learning as the long version of the scale.

Related to sub-study 2, future studies could address the reciprocal cause-effect relationships of personal and organizational antecedents to each other in the context of informal learning. For example, it could be the case that organizational factors such as facets of learning culture act as moderators to influence the relationship between specific personal factors and informal learning. In this scenario, the personal factors would have a proximal effect on informal learning, while the organizational factors would instead have a distal effect. Individual personal and organizational factors alike could also act as mediators to explain the relationship between informal learning and specific learning outcomes. In order to better understand these cause-effect relationships in the future, further empirical studies are needed - especially with experimental and longitudinal research designs, for example, to provide methodologically sound evidence of mediation effects (Maxwell & Cole, 2007; Mitchell & Maxwell, 2013).

Particularly sub-study 3 showed that cause-effect relationships over time in the context of informal learning are still relatively unexplored and that the literature relies - at least partly wrongly - on cross-sectionally studied relationships that are interpreted causally. In this respect, this sub-study is an illustrative example of not interpreting cross-sectional study results outside the methodologically set limits, and of increasingly striving for longitudinal studies.

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[92] First validation approaches have already been made (Decius & Schaper, 2019[a] ; Decius, Dannowsky & Schaper, 2019) - with expected challenges regarding a critical reflection of the Octagon model and a modification of the scale items. Preliminary empirical evidence suggests that the components "model learning" as well as "vicarious feedback" are not separable in the study context. While industrial employees observe manual activities (e.g., specific hand movements) in colleagues during model learning and, if possible, integrate them directly into their own workflow, the exchange of experiences during vicarious feedback takes place on a more cognitive-abstract level. Students usually observe rather abstract behavioral aspects (e.g., a presentation technique used by fellow students during a student lecture) during model learning as well, without directly adopting these for their own work behavior.

[93] A manuscript is already available for a validation study with 747 employees from various sectors and fields of work - especially outside industry - which shows that the short scale is also suitable in principle for the mixed target group mentioned. Nevertheless, further in-depth research is necessary in this regard. The multi-page manuscript (Decius, Schaper & Seifert, 2020[c]) was accepted for presentation in a methodological symposium at the EARLI "SIG 14" conference in Barcelona in July 2020; however, the conference was cancelled for infection control reasons.

Specifically, Substudy 3 raises the question of whether the found effect of informal learning on working conditions (i.e., job demands and decision latitude) is mediated by job crafting. This should be tested in future longitudinal studies. In addition, it would be advisable to replicate the quite surprising and in parts contradictory results of the previous literature (i.e., confirming the "active-adaptation hypothesis" while rejecting the "active-learning hypothesis") with a larger sample and also in target groups other than industrial employees in SMEs. In doing so, a special focus could be placed on the length of the interval between the measurement time points[94] .

Although the three sub-studies were conducted with industrial employees in SMEs, it can be assumed that the research results can also be generalized with regard to larger companies, since the work tasks of semi-skilled and unskilled employees hardly differ. Even the work context is comparable, since employees in larger production halls also work predominantly in separate areas and in manageable groups. However, there is also evidence in the literature (although no quantitative empirical evidence) that the nature and expression of informal workplace learning and knowledge management is influenced by plant size (Coetzer et al., 2017; Wong & Aspinwall, 2004). Therefore, the assumption of transferability of the results should be tested in additional studies.

Another aspect that future research should address is the methodology of surveying informal learning in the workplace. In particular, questionnaire surveys were used in the present research. The literature also includes a variety of qualitative studies based on interviews and case analyses (e.g., Crouse et al. , 2011; Eraut, 2007; Lohman, 2003). At this point, the question arises whether other research methods commonly used in applied psychology might also be applicable to informal learning in the workplace. For example, are observational studies of informal learning possible? It is difficult to give a clear answer to this question, because informal learning is seen as a concept consisting of diverse components, as also becomes clear when looking at the octagon model. Some of these components, such as direct or vicarious feedback, are in principle readily amenable to capture through observation. For components of the learning action (own trying out, model learning) this applies likewise, although with certain restrictions. The components of reflection and learning intention, on the other hand, are not

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[94] International researchers are currently conducting a study that has similarities with sub-study 3. Initial evaluations indicate that a long time interval of about one year - in line with the results of sub-study 3 - certainly provides evidence for the "active adaptation hypothesis". However, when considering shorter time intervals of a few months (i.e., additional surveys between the two measurement time points), evidence seems to emerge more in favor of the "active-learning hypothesis" (personal communication with Eva Kyndt, 03.03.2020). This speaks in favor of the job-crafting assumption, since job-crafting processes usually take place over longer periods of time.

visible to observers. Here, it is necessary to involve the employees in the research data collection.

What about the potential uses of field-based intervention studies in the context of informal learning? For example, an intervention to promote direct feedback could be to provide communication training to managers - in the hope that employees will subsequently find it easier to seek feedback on their work performance[95]. It should be noted here, however, that informal learning processes cannot be viewed independently of real events and challenges in the work process, and that a wide variety of interdependencies in the organizational environment thus arise over time. In addition to manifold social exchange processes, changes in the general economic conditions and the strategic orientation within the company also play a role. Evaluating the effect of individual intervention measures on relevant criteria of learning success is therefore even more difficult than with formal training measures.

Are experimental laboratory studies also possible in the area of informal learning with indus trie try employees? The answer to this question is: in principle, yes. However, it should be noted that corresponding research designs are associated with a high level of effort. Experiments under laboratory conditions would have to contain real problems and challenges from everyday working life in order to adequately depict problem-induced and work-related informal learning. In the case of very concrete scenarios, however, the participants are assumed to be people with a certain amount of industrial experience - for example, in dealing with machines, tools or occurring errors in manufacturing and assembly. Here, it might be an easier option to focus on the informal learning of novices (e.g. industrial apprentices) in order to make the experimental setup more standardized and to expect less prior knowledge from the participating persons[96].

Overall, it can be stated that relatively little is known so far about informal workplace learning in different occupational target groups, and that the methodological spectrum of research designs is far from exhausted - possibly also because of the potential challenges in their implementation. Combining different methods in future research could mitigate potential

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[95] This example is based on a cooperation with a manufacturing SME carried out within the extended scope of this research work, in which the informal learning of employees was to be promoted over a period of several months, among other things through training programs for managers. However, a quantitative pre-post comparison did not show a significant improvement in informal learning, but in some components even a decrease in self-reported learning behavior (cf. Decius & Schaper, 2019[b]). One reason for this could have been sensitization processes in the workforce, as the scientific monitoring of the intervention and the accompanying surveys could have led to higher expectations regarding hoped-for improvements (possibly a type of "Hawthorne effect", see e.g. Nerdinger, 2019, p. 24).

[96] See, for example, the study by Schüffler, Thim, Haase, Gronau, and Kluge (2019) on intentional forgetting of a previously learned production routine, which was conducted with students in the laboratory context of a learning factory.

biases associated with the widespread research practice of predominantly using self-assessment scales in questionnaires.

Another research desideratum concerns the interaction and integration of different forms of learning, since in practice they often overlap and are interleaved (cf. chapter 3.4). In the past, various research directions often concentrated on one preferred form of learning, ignored the existence of other forms of learning or used them only to contrast and present the advantages of "their" form of learning. On the positive side, however, there have been isolated approaches to integrating informal and formal learning (e.g., Bishop, 2020; Greenhow & Lewin, 2016; Ellström, 2001; Svensson, Ellström, & Åberg, 2004). A cross-sectional study by Choi and Jacobs (2011) with managers in the banking sector also found that the relationship between the work environment and informal learning is entirely mediated by formal learning. However, other forms of learning outlined in section 3.3 are rarely considered in such attempts at integration. This task of creating links between the scattered learning form "islands" - which are often less far apart than thought - is one that scholars should devote more attention to and further theoretical considerations as well as empirical studies on.[97] Future research could develop an integrated theory of work-based learning based on the dimensions presented in Chapter 3 for characterizing learning forms, placing learning forms in the context of work-based learning, and delineating learning forms in terms of structure and content. The literature review in the context of the present research shows that learning concepts originating from different theoretical perspectives have not yet been combined and integrated without contradictions, but such an effort should prove worthwhile for the discourse on educational theory. At this point, this paper follows the suggestion of Noe et al. (2014), who call for the consideration of work-based learning from a broader, more strategic perspective.

Informal learning has been predominantly considered at the individual level in previous literature - this focus is also critically considered (Gnahs, 2016, p. 113). Further research is needed on how teams and groups learn informally, and how differences and similarities with regard to the learning form of situated learning (Lave & Wenger, 1991) are presented here. Organizations and entire societies are also constantly evolving and learning (cf. Argyris & Schön, 1996; Watkins & Kim, 2018)[98] - research on informal learning in this area is virtually nonexistent. In the workplace context, it is necessary to consider employee learning and managerial learning in combination. From a methodological perspective, such research data can

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[97] For the context of industrial employees in SMEs, the methodology of agile learning as a possible integration of informal, formal and self-regulated components could represent such an approach (cf. detailed explanation in chapter 5.4).

[98] One example of informal and also transformational learning by societies is how to deal with prolonged natural disasters, such as pandemics, which also pose ever-changing challenges in the professional context for many industries.

be analyzed using multi- level analyses, which have been underrepresented in relation to informal learning (Cerasoli et al., 2018; Noe et al., 2014).

As has already been discussed in the course of this chapter with regard to possible interventions concerning informal learning, informal learning takes place in an area of tension between many different company actors and further contextual factors. However, this challenge should not serve as an excuse for science to refrain from investigating ways to support informal learning processes. This is especially true because the question of whether - and if so, how - informal learning can be supported in the workplace is highly relevant for practice.

5.4   Practical implications

One of the fundamental advantages of informal learning for industrial employees in SMEs is that employees who face various learning barriers with regard to formal learning (cf. chapter 1.2) can also undergo further training. However, Gnahs (2016, p. 110) also points out that many people are used to traditional teaching and therefore cannot switch to a self-learning mode without complications. Even if this objection appears less relevant in the case of semi-skilled and unskilled employees, SMEs should take care to address the habits and interindividual differences of employees when creating conditions for informal learning that are conducive to learning.

SMEs should also get a clearer picture of which components of informal learning are pronounced in certain departments and groups of people in their company and to what extent. To this end, HR managers in SMEs can refer to the scale developed in sub-study 1 to operationalize informal learning in the workplace based on the Octagon Model. Using the scale makes it possible to gain an overview of informal learning in the workforce and to adjust any support measures accordingly. For example, one area of work might be more reliant on learning through trial and error and should be given the freedom to do so - including encouragement to make mistakes, which would be less desirable in areas such as quality control. There, on the other hand, employees could make greater use of the reflection components of informal learning and should be given time and quiet to reflect on their own work. Still other areas, in which, for example, more learning takes place through vicarious feedback, should be given further opportunities to exchange experiences among colleagues (e.g., an acoustically shielded "conversation island" in the production hall).

Marsick, Volpe and Watkins (1999, p. 93) emphasize that informal learning should not be left completely to chance. However, targeted support for informal learning is considered difficult because learning takes place out of the work process and cannot be planned by the

company[99] . The only possible way is indirect support via the provision of framework conditions conducive to learning (Cerasoli et al., 2018; Ellström, 2011; Skule, 2004; cf. Decius et al., 2020[a]). Therefore, HR managers in SMEs should think about how they can best create these conditions. Although it was possible to identify certain levers for promoting informal learning in sub-study 2 with the antecedents, it is questionable whether these can be influenced in the everyday practice of SMEs. A large number of personal factors, particularly with regard to predominantly stable personality characteristics ("traits"), can only be made usable for informal learning by managers in SMEs in the long term through adapted personnel selection procedures. However, this presupposes that the relevant personal characteristics of the applicants are known - in view of the limited resources of SMEs in the human resources area without and the consequently less likely use of valid selection procedures, this is a rather hypothetical starting point[100] .

It seems more promising to influence the organizational antecedents of informal learning - especially those for which managers are directly responsible. One example is social support, which showed a remarkably high correlation with informal learning in sub-study 2. For example, managers in SMEs could act as role models in terms of obtaining and offering feedback on work performance. Should errors occur in the work process, managers could emphasize the learning potentials of the respective situation and thus create a positive error culture in the long term (Putz, Schilling, Kluge & Stangenberg, 2013). This applies in particular to admitting one's own failures and dealing constructively and proactively with failures in order to set a good example for employees. Employees can also be encouraged to recognize and take advantage of learning opportunities. Individuals who are particularly good at this could also be encouraged to act as "learning experts" to support their colleagues in informal learning (Cerasoli et al., 2018; cf. Decius et al., 2020[a]).

In addition, SMEs can try to build up the metacompetence "learning to learn" among their employees (cf. Erpenbeck, 2006; Renkl, 2008; Weinert, 1999). In addition to support from more experienced colleagues, this can also be done through formal training or as part of official mentoring programs. Here, too, the focus is on recognizing learning opportunities early on, perceiving dynamic and unexpected situations as learning opportunities, and using problems and mistakes positively for one's own competence acquisition (cf. Cerasoli et al., 2018). Employees who are aware of the many different facets of their learning process, can understand the connections between the challenges of the job and their learning success, know their

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[99] Marsick et al. (2009) admit: "We do not yet understand how to support informal [...] learning without making it artificial or destroying it with too many rules and regulations" (p. 594).

[100] However, as presented in Substudy 2, there are also approaches to implement training interventions regarding learning goal orientation (which is considered a rather stable characteristic of a person) among unemployed people (Noordzij, Van Hooft, Van Mierlo, Van Dam & Born, 2013).

opportunities and limitations, and seek support from others when needed are likely to be particularly effective informal learners. However, further research on this is also pending.

In learning support training and mentoring programs, workers can also be made aware of the downsides of informal learning - known as the "dark side" of informal learning (Cerasoli et al., 2018). These include, for example, when workers informally learn bad habits from colleagues, develop counterproductive work practices (e.g., bypassing safety precautions on machines), and are influenced by negative role models and misguided incentives (Cerasoli et al., 2018, p. 224; Dale & Bell, 1999, p. iv). "Informal learning lacks a corrective in the sense of a teaching person who, for example, illuminates the learning content or else the skills and abilities from a different point of view. [...] [Thus] the distancing from the subjective worldview is missing here" (Carstensen & Hof, 2015, p. 133). Accordingly, the organization has no control over the learning of its employees (Sitzmann & Weinhardt, 2018, p. 749).

It can therefore be assumed that formal training and instruction, especially on safety-related topics, will continue to be of great importance in certain areas in the future (cf. Marsick & Watkins, 1990, p. 35[101]) - if only to be able to provide written documentation for legal reasons that the prescribed formalities have been observed in the event of subsequent occupational accidents. In complex technical environments with high risks of operating errors (e.g., in aviation or nuclear power plants), workers also often acquire necessary competencies in simulation settings and under the supervision of an instructor (Bartram & Roe, 2008) in order to monitor the acquisition of competencies and ensure a high quality of the learning content. However, the use of such elaborate procedures for simple industrial work is not recommended from a cost-benefit perspective.

Overall, the downside of informal learning in the workplace has hardly been researched so far, so that little is known about the prevalence of these behaviors and their effects on the work process. Even industry-specific differences in the relationship between the possible advantages and disadvantages of informal learning can so far only be speculated on. It should be noted, however, that companies have little influence - positive or negative - on the content of informal learning.

A potentially promising approach to predominantly maintain the advantages of informal learning, while at the same time granting companies more opportunities to control the learning content, is the method of agile learning. Agile learning can be classified as a concept

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[101] Marsick and Watkins (1990) quote here from the preface by Harry Overstreet in the seminal work Informal Adult Education by Malcolm Knowles (1950): "There are times when a formal course of instruction, given in the regular way of teacher, textbook, recitations, examination, and credit, is precisely what an adult must have if he is to fulfill certain requirements of his later life. There are, however, other times - and these more frequent - when what he most needs is not and could not be found in any formal course of instruction. [Overstreet in Knowles, 1950, p. v]"

for work-integrated qualification and is based on the structure of agile project management (Chun, 2004; cf. Preußig, 2018), which is used in particular in software development. Analogous to the *Scrum* project management methodology (see e.g., Dräther, Koschek & Sahling, 2013), agile learning distinguishes between three roles: Client, Learning Master/Coach, Learning Team (Höhne, Bräutigam, Longmuß & Schindler, 2017; Longmuß, Grantz & Höhne, 2018). The learning team (i.e., employees who come together in a project) receives its learning goal from the client (e.g., the SME's management). The path to the goal is not predetermined, so learning involves a high degree of self-direction. The learning is divided into "learning sprints": Learning team members coordinate independently and set individual or collective learning and outcome goals for each stage ("sprint"). They also motivate and monitor each other's goal achievement through regular appointments. In this process, the learning team is supported by the learning master, who ensures the supply of sufficient learning resources and is available as an advisor for learning optimization. In some approaches to agile sprint learning, the role of the learning master is further subdivided and a distinction is made, for example, between the *sprint* facilitator (who takes care of the aspect conducive to learning as well as the social support during learning) and the *subject matter expert* (who, as the knowledge carrier for the respective learning topic, has technical responsibility for the content) (Jungclaus, Korge, Arndt & Bauer, 2019).

The agile learning approach, which has already been piloted in industrial companies (Höhne et al., 2017; Longmuß et al., 2018), involves partly self-regulated learning, although the learning objectives are externally specified, but also partly informal learning, as the learning and work processes are interwoven and new challenges to be solved can always arise. However, through the specification of learning objectives and the guidance by the learning master, formal parts are also present, so that the companies gain greater control over the use of resources and the expected learning outcomes, which counteracts the "dark side" of informal learning. Therefore, it appears to be advantageous for SMEs that have to manage with low financial budgets for human resource development to invest financial resources for training in this way (e.g., for employees to be released from other work tasks on an hourly basis to participate in agile learning projects). However, it should also be noted that planning the learning process limits one of the greatest strengths of informal learning - the freedom of location and time to learn in response to spontaneously arising learning needs. Therefore, the use of agile learning methods cannot replace problem-induced informal learning in the workplace, but it could provide an interface between formal, self-regulated, and informal learning. It may also be possible to acquire metacompetencies such as "learning to learn" in agile learning projects, which employees can subsequently use for efficient informal learning. The extent to which agile learning can be a useful addition to the further training of industrial employees in SMEs should be increasingly investigated and tested in practice in the future.

If SMEs promote informal learning among their employees, they can expect not only the learning outcomes examined in sub-study 2, but also positive effects through possible job-crafting effects, as the results from sub-study 3 suggest. These effects could include, for example, higher levels of job satisfaction, job engagement, and job performance, as well as employees' willingness to take on greater responsibilities in the work process (Parker, Wall & Jackson, 1997; Rudolph, Katz, Lavigne & Zacher, 2017). The extent to which potential negative effects - for example, that a person striving for higher work demands with simultaneously greater decision-making scope following informal learning cannot be retained in the company because such a position is not available (Frese, Garst & Fay, 2007) - play a role in SME practice, or represent a rather hypothetical scenario, is not yet known.

Despite all the advantages of informal learning, companies should not regard this form of learning as a "panacea". Formal learning and other forms of learning will continue to be important in continuing vocational training in companies, e.g. with regard to the safety training already mentioned, which is required by law and must be verified (cf. Chapter 1.3). Therefore, SMEs should not put all their eggs in the "informal learning" basket, but rather focus on the individual needs of their employees and provide a mix of diverse continuing education offerings. The sys te ma ti them tion of work-related forms of learning (cf. chapter 3) carried out as part of this research work, including the practical examples of application (see table 10), can be helpful here. The temptation may nevertheless be great to offer hardly any more formal training with reference to a high percentage of informal learning in total work-related learning, to see the responsibility with the employees themselves and thus to want to save financial resources. Garrick (1998, p. 5) also pointed out early on the dangers of such an "economic appropriation" (Rohs, 2016, p. 24) of informal learning and the possible "instrumentalization of a form of learning for increasing the value of the workforce" (Kirchhöfer, 2004, p. 84). Gnahs (2016) puts it in a nutshell:

Learning potentials are replaced by learning constraints, lifelong learning as an option becomes 'lifelong' learning as a permanent obligation and as a societal [and company] expectation. [...] As a result, every conceivable window of time is used for learning in order to avoid idleness and to drive self-optimization. (S. 110-112)

Instead, SMEs should try to create the best possible framework conditions for informal learning and focus on their strengths: The often short decision-making paths, social proximity, and family togetherness are considered to be conducive factors for informal learning in the workplace (Coetzer et al., 2017). If HR managers transfer the scientific findings into operational practice without developing excessive expectations, they have a good chance of being rewarded by sustainable learning successes of their employees. After all, who knows, you might

think: Perhaps informal learning ultimately has a parallel with quantum physics? When a "quantum observer" watches, quanta change their behavior (Buks, Schuster, Heiblum, Mahalu & Umansky, 1998). Analogously, one might conjecture: If one tries to target and evaluate informal learning in the workplace, one may get different learning behavior than intended. How efficient and effective this learning behavior may be compared to "unobserved" informal learning in everyday work remains an intriguing question.

6. Conclusion and outlook

Informal learning on the job is an important form of continuing education, especially for industrial employees in SMEs. For this target group, it has certain advantages compared to other forms of learning, especially compared to formal learning, which outweigh any disadvantages (keyword: "dark side" of informal learning). While informal learning should not be glorified as a "miracle cure" of continuing education, it should nevertheless be understood as a useful way for employees to learn and address challenges in a problem-induced way in the work process. This research contributes to conceptualizing informal learning, distinguishing it from other forms of learning, and operatio nalizing it with the help of a quantitative measurement instrument based on scales. In addition, the results of this work make it possible to quantify the strength of the relationships between ante cedents and learning outcomes of informal learning and to derive options for supporting learning and designing frameworks conducive to learning. With regard to working conditions, namely *work requirements* and *scope for decision-making, it was* possible to uncover the causal direction of effect in interaction with informal learning: Informal learning influences working conditions, not vice versa. SMEs can make use of these findings and integrate them into their day-to-day work. For an effective transfer of the scientific results, further practical papers and guidelines for industry are desirable in the future.

However, it is still open to what extent the results of the present research can be transferred to other target groups outside of industry, and whether a modification of the octagon model and the measurement instrument is necessary in this context. In addition, it is still largely unexplored how informal learning can best be intertwined with various other forms of learning, and what interactions exist between various constructs and informal learning over time-particularly with respect to the ante cedencies and learning outcomes of informal learning. To answer these questions, further studies - longitudinal, multimethod, and looking at multiple levels of influence - are necessary and desirable. Compared to other topics in industrial and organizational psychology, research on informal learning in the workplace is thus still at the beginning of a longer path of knowledge. The present research work is *a* scientific

step on this path - more will certainly follow in the near future in view of the increasing practical and theoretical relevance of the topic.

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