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Exploring the interplay between vocational competence and dropout intention: insights and perspectives

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Abstract

High drop-out rates from Vocational Education and Training (VET) remain a severe problem in VET systems globally. Despite decades of drop-out research revealing numerous influencing factors, the role of trainees' vocational competence in their drop-out behavior has been neglected. This study aims to define the structure of vocational competence and analyze its effects on drop-out intention. Using longitudinal data from 458 commercial trainees in Germany, vocational competence is measured at three time points using a validated competence test, subdivided into domain-linked and domain-specific dimensions (Gelman and Greeno, 1989). Four different directions of drop-out intentions are considered, enabling a detailed effect inspection of the prevailing research gap. Additionally, factors identified in previous studies, such as educational level, age, language, and the degree of having chosen one's desired occupation, are controlled for. We conducted 12 rounds of ordinal logistic regression to test three lagged temporal combinations of the effect relationship between vocational competence and dropout intention over different time spans (T0->T1, T1->T2, T0->T2). We find that lower domain-specific competence increases the intention to drop out from VET without qualification over different time spans. Initial lower domain-specific competence also affects trainees' intention to change their occupation in the final year of training. Furthermore, higher levels of domain-linked competence at the beginning increase the intention to leave VET to pursue higher qualifications in the midterm of training.

Keywords: Vocational education and training, Drop-out, Vocational competence, Domain-specific competence, Domain-linked competence, Longitudinal design, Hierarchical multiple regression

Introduction: is competence relevant for drop-out intention?

Drop-out can be identified as the most significant challenge facing VET, resulting in the loss of approximately 150,000 highly skilled workers annually in Germany alone (Bundesinstitut für Berufsbildung [BIBB] 2020, 2021, 2022). These untapped potential hampers efforts to address the skilled worker shortage (BIBB 2022; DGB-Bundesvorstand 2020; Ulrich et al. 2020). According to CEDEFOP (2016), European adult education survey (AES) data suggest that, on a broad scale, the percentage of early leavers

from Vocational Education and Training (VET) programs is higher than those departing from general education. At the national level, data from 2014 in France illustrate significantly elevated early leaving rates from education and training, with 56% among those in VET pathways, compared to 24.1% in general education. Similarly, in the Netherlands, dropout rates are notably higher in VET (5.7%) compared to general education programs (0.6%). This pattern persists, even as the Netherlands maintains its standing as a top performer in minimizing early school leaving, boasting a mere 5.3% rate in 2021 compared to the EU's 9.7%, with a substantial proportion stemming from VET (Ministry of Education, Culture and Science [OCW], 2022c). From 2010 to 2020, Germany witnessed a gradual increase in the dropout rate, registering a cumulative surge of 2.1% throughout the decade. In 2020, approximately 25% of trainees terminated their involvement in VET. Notably, certain training occupations exhibit even higher dropout rates, for instance, 44.8% in hairdressing and 44.1% in building and object coating (BMBF 2022). Given the global prevalence of high and, in some instances, increasing dropout rates from VET (CEDEFOP 2016) and the concurrent shortage of skilled workers (Uhly 2015), dropout has become a focal point in VET research, empirical analyses investigating the determinants and correlates of dropout have garnered significant attention in the field.

With over 600 identified dropout reasons (Böhn and Deutscher 2022), a majority pertain to non-cognitive factors such as encompassing trainees' sociodemographic background, personal plans, training conditions (e.g., Bessey and Backes-Gellner 2015; Callan 2005; Cully and Curtain 2001; Beicht and Walden 2013), as well as motivation and interest (e.g., Findeisen et al. 2022; Berweger et al. 2013; Hasler 2016). In studies exploring the relation between competence and dropouts, a predominant emphasis is placed on key competencies according to definition of OECD (2005). These key competencies encompass interdisciplinary skills across multiple domains. For example, Ulrich et al. (2020) showed that social, methodical, and personal competences are capable of explaining 10% of variance in trainees' drop-out tendency. Especially social competences, such as the ability to cooperate, social responsibility, and conflict ability, exerted significant effects but also reflexivity and work techniques (methodical competence) as well as trainees' sense of duty (personal competence) showed an influence on the drop-out tendency (ibid. p. 195). Likewise, Weber and Garcia-Murias (2019) pointed out that especially conflict abilities but also meta-cognitive competences such as career management skills have an impact on drop-out behavior. Holtmann and Solga (2023) extended the scope by incorporating mathematics and reading competence to explain dropout phenomena. These competencies gauge the readiness for training, assessing whether the young people have the basic school knowledge and psychological performance characteristics (Baas et al. 2012; Schuster 2016). Zumbühl and Wolter (2017) compared the effect sizes of non-cognitive variables on drop-out behavior while controlling and not controlling these general competencies in terms of the readiness for training, which includes both the basic school knowledge such as the PISA test results in mathematics, in language, and in the natural sciences, and psychological characteristics, such as trainees' punctuality. The findings revealed that the effects of gender, migration background, and age varied when broadly conceptualized competencies of trainees' were taken into account in the analysis.

While these earlier studies delving into the relationship between competence and dropout are very insightful, there seems to be a notable gap in research focus regarding the role of vocational competence in understanding the drop-out phenomenon. In this article, vocational competence is conceptualized as cognitive dispositions for achievement within specific focused vocational domains. Theoretically, according to Klieme et al. (2008), competence functionally relates to situations and demands in specific domains. The scope of these domains or of the relevant situations can vary from highly specific competencies in narrow domains to broadly conceptualized key competencies. Empirical studies also confirmed that general competencies and competencies in narrow domains are correlated and yet separable constructs (Wirth et al. 2005). Although these earlier studies have not directly provided evidence for the relationship between vocational competences and dropout, certain indications of a potential link between "vocational competence" and drop-out behavior can be found. For instance, Zumbühl and Wolter (2017) confirmed the effect of trainees' general mathematic ability on drop-out from VET. This observation is noteworthy as mathematical ability serves as (1) a key predictor for vocational competence in various studies (e.g., Abele 2014; Dietzen et al. 2014; Frank et al. 2017; Krötz et al. 2022; Nickolaus et al. 2009; Seeber 2014) and (2) an integral component of vocational competence in commercial education and training, encompassing economic numeracy (as detailed in the subsequent section). Consequently, these findings suggest a relation between vocational competence and dropout behavior. Furthermore, Beicht and Walden (2013) investigated whether the perceived difficulty of the training explains dropout behaviors. Similarly, Berweger et al. (2013) explored whether poor performance by trainees in schools and companies correlates with dropout. Although these pieces of evidence suggested a potential role of vocational-related competence on dropout, it's noteworthy that these studies rely on subjective self-reports from trainees. The methodological approach of utilizing subjective self-report data has some limitations that we aim to address in the current study: Firstly, when considering the construct being measured, a critical aspect is the dimensionality of vocational competence. Notably, recent advancements, exemplified by projects like the BMBF's ASCOT research program (summarized in Beck et al. 2016), have made substantial progress in modeling the structure of vocational competence. However, evaluating vocational competence through items like perceived training difficulty or general performance in schools and companies seems to treat it as a unified concept, potentially overlooking the nuanced differentiation into sub-dimensions, which may function differently in predicting dropout. Secondly, there is a need to reflect on the reliability of using perceived difficulty and performance in vocational schools and companies as indicators of vocational competence. This raises questions regarding whether subjective perceived difficulty may be influenced, in part, by psychological characteristics or transversal competencies (Baas et al. 2012; Schuster 2016). Additionally, it raises inquiries about the extent to which performance in vocational schools and companies genuinely represents vocational competence. Factors such as contextual elements (e.g., resource availability), personal circumstances (including external stressors), and the breadth of the construct to be measured may impact performance and need careful examination in this regard. Thirdly, the reliance on subjective self-report data evaluated through a

Likert scale, typically ranging from 5 to 7 points, poses challenges in terms of obtaining a nuanced understanding of competence. A finer degree of differentiation in responses might enhance accuracy in competence evaluation. Fourthly, the absence of longitudinal research hampers the exploration of long-term effects. Longitudinal data is instrumental in identifying patterns, correlations, and trends in training progression, establishing temporal relationships between variables (Caruana et al. 2015). In a preceding study examining the relationship between training quality and drop-out intention using a cross-sectional approach, no effects were found for vocational competence test scores on drop-out intention (Krötz and Deutscher 2022). It is worth considering whether tracking the progression of dropout intention and competence over several years would be beneficial, enabling an assessment of how competence influences dropout intention across different time spans.

In light of these considerations, it is worthwhile to optimize research methods and close the research gap on the relation between a rather cognitive, specific competence facet and drop-out. This is pertinent because on the one hand, the cognitive competence facet, unlike stable personal characteristics, is a malleable construct open to training, which can improve throughout education and training (Ma et al. 2024). This indicates the importance of appropriate support from schools or companies during vocational training. On the other hand, vocational skills, knowledge, and competences are explicitly outlined in the training regulations or framework curricula in BBiG Teil 1 Allgemeine Vorschriften § 3 (Bundesministeriums der Justiz und für Verbraucherschutz, 2005), and the primary objective of VET is to foster the development of vocational competence (Deutscher and Winther 2018). Among individuals aged 16 to 64 who are unskilled or semi-skilled, 28.3 percent have initiated vocational training/apprenticeship in their lives but subsequently discontinued it or did not pass the final examination (Flake et al. 2014). This data carries two implications: firstly, it suggests that this 28.3 percent of the 7.5 million unskilled and semi-skilled individuals could potentially become skilled workers if they had successfully completed the training. Therefore, gaining a better and more nuanced understanding of the influence of vocational competence on dropout intention holds significant practical implications for policymakers and VET curriculum designers. Secondly, it indicates that the reasons for discontinuation can be varied, however, failure in the final examination may indicate that the lack of competence is one of the contributing factors.

Another point worth mentioning is that in the realm of existing research investigating dropout phenomena, the predominant focus has been on studying dropout behavior, with only a limited number of studies, such as Findeisen et al. (2022), delving into the exploration of dropout intentions. Our current research uniquely directs its attention to the nuanced analysis of dropout intention throughout vocational training. This emphasis is grounded in the recognition that dropout behavior represents a singular event, while dropout intention unfolds through a developmental process. Investigating dropout intention facilitates the early identification of individuals contemplating program departure, enabling timely interventions to preempt actual dropout. Moreover, recognizing dropout intention as a predictive indicator of future behavior empowers institutions to proactively address factors contributing to dropout rates and finally reduce dropout rates. The dynamic nature of decision-making is

encapsulated by studying dropout intention, providing a comprehensive understanding of evolving reasons behind the decision to stay or leave a program.

To delve deeper into this relationship between vocational competence and dropout intention, we employ standardized and objective testing to assess vocational competence across three measurement points. This longitudinal design proves particularly valuable for gaining insights into the temporal aspects of the relationship between vocational competence and dropout intention throughout the training progression. Additionally, we distinguish vocational competence into two dimensions—domain-specific and domain-linked competence. Similarly, we categorize dropout intentions into four distinct directions: upwards, downwards, company change, and occupation change. The domain in which we conducted our analysis on the relationship between vocational competence and dropout intention is economics occupations (Kaufmännische Ausbildungsberufe). These training occupations in Germany are focused on providing individuals with skills and knowledge in business and management. Examples of "kaufmännische Ausbildungsberufe" include roles such as "Kaufmann/-frau im Einzelhandel" (Retail Salesperson), "Kaufmann/-frau für Büromanagement" (Office Management trainees), and "Industriekaufmann/-frau" (Industrial Trainees). The training typically covers areas like business administration, office management, and commerce, preparing individuals for roles in various sectors of the business world (Brötz and Kaiser 2015). On the one hand, as reported in the National Education Report (2022), while the number of dual graduates with non-German nationality increased between 2017 and 2020, trends within the German dual system reveal a decline in the number of graduates across all considered occupational groups in 2020, including in commercial occupations. On the other hand, according to Statistisches Bundesamt (2023), commercial training occupations were among the most popular training occupations in 2022, the most common assigned training contracts correspond to the occupation of "Kaufmann/-frau im Einzelhandel" (Retail Salesperson). Following closely is "Kaufmann/-frau für Büromanagement" (Office Management Clerk), and in the 7th position is the occupation of "Industriekaufmann/-frau" (Industrial Clerk). The reported statistics emphasize the importance of understanding the factors contributing to dropout intentions and addressing potential challenges or issues leading to a decrease in the number of graduates in commercial training occupations in Germany, considering their prevalence and significance in the training landscape.

Theoretical grounding

Two dimensions of vocational competence

In this section, we will delineate the construct of vocational competence. In the first step, we will establish the boundaries of vocational competence in our research, determining what is to be included and excluded. Subsequently, in the second step, we will model the dimensionality of vocational competence.

In the German-speaking context, Heinrich Roth (1971) identified three sub-competencies within the framework of professional action competence (known as "berufliche Handlungskompetenz" in Germany): vocational competence, social competence, and personal competence. Expanding beyond cognitive aspects, Weinert (2001) includes motivational orientations, attitudes, tendencies, and expectations

in his competence concept within the discussion of professional action competence. Professional action competence enables individuals to act in an appropriately considered and individually and socially responsible manner in professional situations, aligning with the primary goal of VET (Hensge et al. 2009). This encompasses not only vocational competence but also interdisciplinary key competencies and motivational facets. However, in this research, to maintain occupational relevance, we focus specifically on vocational competence. Consistent with Klieme et al. (2008), we define competence as cognitive dispositions that functionally relate to situations and demands in specific domains. The scope of these domains or relevant situations can range from highly specific competencies in narrow domains to broadly conceptualized key competencies. The vocational competence construct used in this study is limited to a specific occupational domain.

Following the distinction by Gelman and Greeno (1989) and several studies from the business management domain (e.g., Klotz 2015; Lehmann and Seeber 2007; Rosendahl and Straka 2011; Winther and Achtenhagen 2009; Winther and Klotz 2014, 2014), vocational competence is understood as a two-dimensional construct, consisting of a domain-linked and a domain-specific facet. Domain-linked competence comprises generic skills and fundamental knowledge related to economic content (Winther 2011; Winther et al. 2013). This includes economic literacy and numeracy that are fundamentally necessary to solve problems in the domain of commercial occupations, e.g., when converting currencies from Euro to Dollar, and do not require situation-specific knowledge or skills acquired in training (Winther et al. 2013; Klotz 2015). Domain-specific competence targets job- and task-specific problem-solving and, therefore, comprises the necessary rules, guidelines and principles acquired over the course of training that need to be applied to solve daily work tasks, generating situational knowledge and skills over time. An example of a mainly domain-specific requirement for commercial occupations would be to conduct a forwards price calculation, applying one's specific skills by using newly learned schemes (Klotz et al. 2015). At the start of training, trainees may lack domain-specific competence due to limited experience in handling specific situational problems. However, they may possess some general economic knowledge and domain-linked competence, particularly in economic numeracy and literacy (Winther 2010; Klotz et al. 2015). As training progresses within a mainly domain-specific framework curriculum, trainees gradually acquire specific knowledge, rules, heuristics, and skills relevant to the domain (Hager 2004; Klotz et al. 2015; Winther 2010; Winther et al. 2013). Consequently, domain-specific competence advances more rapidly and to a higher level throughout the training compared to domain-linked competence (Klotz and Winther 2016; Rosendahl and Straka 2011). The developmental perspective on the two dimensions of vocational competence highlights the importance of monitoring their changes and examining their impact on dropout at various stages. Additionally, empirical evidence suggests that students' engagement and activities in the first semester predict academic achievement and persistence (e.g., van der Meer et al. 2018; Lange 2020). Therefore, we assume it is crucial to analyze the short- and long-term effects of vocational competence at the initial measurement time point.

Four directions of drop-out intention

Before introducing different directions of dropout intention, a clear definition of dropout from VET is required. Firstly, we distinguish between the terms dropout, "premature contract terminations" and "termination of training." According to Uhly (2015), not every termination of training is accompanied by a premature contractual termination. Terminations of training can also occur if no final exam is successfully passed because training contracts are temporary and do not need to be extended if trainees fail a final exam. In turn, not every premature termination of the contract represents a termination of training. It is important to distinguish between those who drop out and become early leavers and those moving to a different program or starting a new apprenticeship contract with another employer. Early-leavers refer cases where the dropout is permanent and irreversible from other forms of discontinuation, such as temporary breaks or interruptions. "Prematurely-terminated training contracts" is the overarching term and defined as contracts terminated before the end of the training period specified in the vocational training contract. This includes contract terminations without or with a complete termination of training in the dual system, implying all individuals who achieved a lower secondary level of education or less (i.e., ISCED 0, 1, 2, or 3c short according UNESCO 2015) and enrolled at least in an education program which they did not complete. In this article, we define dropout as premature contract terminations. Accordingly, dropout intention in VET can be understood as the premeditated inclination or expressed intention of trainees to terminate their participation in the current vocational training program before its completion. It reflects their decision or willingness to withdraw from the current program prematurely for various reasons.

On various levels, drop-outs entail a wide range of mostly negative consequences (e.g., lower tax revenues, higher social welfare expenses, increasing shortage of skilled workers, costs of companies to fill the vacancy or vacant positions, lost investments, etc.). However, from the individual's perspective, the consequences of drop-out depend on the direction taken after dropping out, for instance, the individual could visit university or start a new vocational training in another occupation (Krötz and Deutscher 2022). Therefore, building upon the work of Feß (1995) and Faßmann (1998), we delineate four distinct directions of dropout intention: (1) upward dropout intention involves intention of prematurely leaving their current vocational training to pursue higher education outside of VET, such as enrollment in a university. As per the National Education Report (2022), for 13% of young individuals, continuing formal education by attending school serves as an alternative to reengaging in full-qualification training. Immediately following the discontinuation of their initial training, nearly two-thirds of these young individuals are already back in school with the goal of obtaining a higher general education qualification. Additionally, a small percentage of young people (almost 4%)—approximately a third of those examined here with a (technical) university entrance qualification—opt to leave training to embark on a university education. In Holtmann and Solga's (2023) study investigating risk factors for dropout in VET, approximately 2% of all dropouts transitioned to a university program. (2) Downward drop-out intention entails intention of dropping out of their current training program without a qualification, leading to employment in unskilled jobs or unemployment (Faßmann 1998; Feß, 1995). According to the National Education Report (2022), nearly two-thirds of the apprentices

who experienced downward drop-out, among whom approximately 14% find themselves in fragmented pathways characterized by frequent shifts between various activities. Many spend months in the transitional sector, and nearly a quarter undergo at least two measures, often without leading to a return to formal training. Another 11% experience long periods of unemployment or (unqualified) employment (12%). Horizontal drop-out encompasses cases where trainees prematurely terminating their training within the same educational or training system for occupational reorientation within the dual system, and for a fundamental reconsideration of occupational choices with the goal of identifying another suitable training occupation (Faßmann 1998). Therefore, a horizontal dropout intention can be further categorized into the intention of (3) dropping out for changing the company and (4) dropping out for changing the occupation (Krötz and Deutscher 2022). While there is distance between dropout intention and behaviors, the findings from the National Education Report (2022) shed light on certain issues. According to the report, 47% of the dropouts examined eventually re-engage in dual training after discontinuing their initial training relationship, encompassing both immediate and delayed re-entry into training. Holtmann and Solga's (2023) study aligns with this pattern, revealing that 49.9% of all dropouts are classified as occupational stopouts, while 17.1% fall into the category of company stopouts. In this context, it is important to recognize that not every dropout should be considered inherently negative for the individual. For instance, cases where there is a mismatch between occupational requirements and individual abilities might lead to a more suitable training occupation through a new training contract (Feß, 1995; Schmid and Stalder 2012). However, as indicated by the National Education Report (2022), the diverse pathways following training dissolution, including fragmented trajectories (14%), extended periods of unemployment (11%), or (unqualified) employment (12%), underscore the complexity and challenges faced by individuals discontinuing vocational education and training. Holtmann and Solga's (2023) findings also reveal that 25.3% of dropout cases involve individuals who dropped out from education and training system for at least one training year.

Research question and hypotheses

Based on the research desiderate concerning the relationship of vocational competence and dropout intention and the longitudinal design, the research question of the presented study is: To what extent do the two dimensions of vocational competence influence the various directions of dropout intention during vocational training, while controlling for non-cognitive factors and factors related to the individual's readiness for training?

Although direct evidence regarding the influence of vocational competence on dropout intention is lacking, our initial hypotheses regarding the domain-linked dimension of vocational competence draw from several studies highlighting the pivotal role of mathematical proficiency in successfully completing vocational training (e.g., Abele 2014; Dietzen et al. 2014; Frank et al. 2017; Krötz et al. 2022; Nickolaus et al. 2009; Seeber 2014; Zumbühl and Wolter 2017). Domain-linked competence encompasses the application of foundational knowledge acquired in general education to specific occupational contexts. In the commercial domain, which is the focus of this study, economic numeracy constitutes a key aspect of domain-linked competence, incorporating mathematical

abilities. Therefore, we posit that domain-linked competence diminishes the likelihood of downward dropout (H1a). Moreover, considering that economic numeracy, rooted in mathematical skills, is essential for addressing challenges across various commercial domains such as banking, real estate, and wholesale and foreign trade, we expect that domain-linked competence assists trainees in surmounting obstacles and adjusting to different roles within commercial sectors. As a result, we anticipate an increased intention among trainees to consider switching occupations (H1b) and companies (H1c). Regarding the intention of upward dropout, domain-linked competence in the commercial domain, characterized by occupation-specific mathematical abilities, enables trainees to perceive mathematics as practical, pertinent, integrated, and capable of addressing various vocational mathematical challenges. This functional application of mathematical skills, beyond mere procedural execution, is crucial for tertiary education entry (Büchele and Feudel 2023). Additionally, given the centrality of mathematics in disciplines such as engineering, natural sciences, and economics, trainees possessing advanced math skills may recognize the potential for higher education to unlock a broader array of career prospects and academic pursuits beyond vocational training. Consequently, commercial trainees with high domain-linked competence are more inclined to consider upward dropout (H1d).

The hypotheses related to domain-specific competence are grounded in previous empirical research highlighting key factors contributing to dropout intentions among trainees. Studies such as Ernst and Spevacek (2012) and Schöngen (2003) consistently identify high requirements leading to cognitive overload as crucial reasons for dropout. Additionally, research by Beicht and Walden (2013) and Berweger et al. (2013) confirms that challenges such as difficult tasks within training companies and poor performance are significant contributing factors to dropout. These findings suggest that possessing higher domain-specific competence, particularly in managing demanding situations within the vocational domain, is associated with a decreased intention to dropout downward (H2a), change training occupations (H2b), and switch training companies (H2c). Regarding the intention to dropout upward, it is assumed that as trainees progress in their training, those with high domain-specific competence become better equipped to navigate the practical aspects of their chosen field. They become more adept at handling the demands and challenges specific to their occupation. Vocational training offers immediate entry into the workforce upon completion, providing opportunities for career advancement and job stability. Trainees with high domain-specific competence may perceive these opportunities as more attractive than pursuing further education at the university level. Thus, we hypothesize that domain-specific competence demonstrates the trainee's readiness for the workforce and ability to contribute effectively in their chosen field, thereby reducing the inclination to dropout upwards (H2d).

Methodological approach

Sample

During the "Competence development through enculturation" (KL 3076/2-1) project, we tracked a cohort of $N = 458$ participants enrolled in commercial training programs from 2019 to 2020. The participants were selected from randomly chosen vocational schools in South Germany. The sample comprised 36% male and 64% female trainees, closely

reflecting the current gender distribution of 57.6% females among all new contract signings in 2020 for the training occupation of Industrial Commercial Trainees in Germany (BIBB 2020). This occupation represents the population of our sample. The trainees had an average age of 19.66 years at the commencement of their training, ranging from 15 to 31 years, aligning precisely with the average age for this training occupation in Germany, which is 19.7 years. Notably, a higher-than-usual proportion of trainees held a higher educational entrance certificate (79.8%), compared to the statistical population where 70.7% possessed this highest educational level (BIBB 2020). For additional details, refer to Tables 5, 6 in the Appendix.

Independent variable

We conducted two-dimensional competence assessments, measuring domain-linked and domain-specific competence, at the onset of their training (T0 = autumn 2019), after one year of training (T1 = autumn 2020), and one additional year later (T2 = autumn 2021). Utilizing the validated competence test developed by Klotz (2015), the test consisted of 11 domain-linked and 13 domain-specific items, aligning with the training curricula from both the school and company facets of training. Consequently, as trainees progressed through their training, their ability to solve more extensive portions of the test increased. To ensure a valid performance measurement, the diverse tasks were aligned with a typical business process and embedded in an authentic company framework (Schnick-Vollmer et al. 2015). The tasks encompassed a range from terminology reproduction to action-oriented, realistic requirements, with the latter constituting the majority (e.g., responding to a business email according to DIN-Form). Thus, the test aimed to assess all levels of competence, including conceptual, procedural, and interpretative competence (Greeno et al. 1984). Refer to the Appendix, Fig. 1, for an example of domain-specific items. The tests were primarily conducted in a paper–pencil format but were also validated in an identical online environment (Ma et al. 2023) due to COVID-19 pandemic restrictions. All 458 trainees completed the competence tests across the three years. Given the theoretical assertion that domain-specific and domain-linked competence are two separable yet correlated dimensions, we calculated two-dimensional vocational competence using a between-item multidimensional random coefficients multinomial logit model with correlated dimensions. This model allows for estimating multiple abilities accounting for successful problem-solving in more than one dimension simultaneously, while responses to one item rely upon only one of the dimensions in the model (Hartig and Höhler 2009) (For more information about modeling and calculating the two-dimensional vocational competence, see (Ma et al. 2024)). Thus, in the presented study, the data of vocational competence is located on a logit scale.

Dependent variable

Concurrently with the competence test, a total of 458 trainees participated in the survey to assess their individual drop-out intentions at the initiation of their training (T0 = autumn 2019), after the first year of training (T1 = autumn 2020), and one additional year later (T2 = autumn 2021). Among them, N = 454 trainees completed the survey over the three-year period. Utilizing a short scale for drop-out intention developed by Krötz et al. (2022), the scale consisted of four items, each corresponding to one of the

four drop-out directions (see Table 1). Participants were required to provide responses on a five-level Likert scale (0 = strongly disagree; 4 = completely agree). All items pertaining to drop-out intention were categorized under the general title "intention to drop out of training."

Control variables

In the realm of non-cognitive factors, the literature presents varied findings on basic sociodemographic elements. Holtmann and Solga (2023) noted a significant correlation between age at the start of the initial VET and dropout, while sex and migration background did not exhibit significant correlations. Conversely, Michaelis and Richter (2022) found that migration background significantly influenced dropout, with no significant impact from gender. In our study, we surveyed sex (0, female; 1, male), age, and migration background using the spoken language at home as an indicator. Additionally, prior educational experiences have been identified as crucial factors for dropout (Bessey and Backes-Gellner 2015; CEDEFOP 2016; Holtmann and Solga 2023; Michaelis and Richter 2022; Greilinger 2013; Krötz et al. 2022; Schuster 2016). Therefore, we incorporated trainees' school-leaving certificates, alongside basic sociodemographic information, as control variables in our analysis. The educational level comprises four levels of German school leaving certificates obtained from different school types: "Hauptschulabschluss" (below a secondary school level), "Mittlere Reife" (corresponding to a secondary school certificate), "Fachhochschulreife" (enabling advanced technical college studies), and "allgemeine Hochschulreife" (allowing university studies). Moreover, conflicts with trainers, the social climate, and in-company training quality, in general, can be significant reasons for dropout (Ernst and Spevacek 2012; Faßmann and Funk 1997; Findeisen et al. 2022; Greilinger 2013; Holtmann and Solga 2023; Krötz and Deutscher 2021, 2022; Piening et al. 2010; Quante-Brandt and Grabow 2008; Rohrbach-Schmidt and Uhly 2015; Schöngen 2003; Schuster 2016; Stalder and Schmid 2006). The "person-environment fit" concept emphasizes the role of mismatches between individual personality or abilities and the surrounding company or school environment or occupational requirements. In this context, incorrect expectations by trainees regarding daily training routines, occupational requirements, or their own preferences can result in mismatches, contributing to drop-out incidents (Beicht and Walden 2013; CEDEFOP 2016; Holtmann and Solga 2023; Michaelis and Findeisen 2022; Nägele and Neuenschwander 2015; Quante-Brandt and Grabow 2008; Michaelis and Richter 2022; Schuster 2016; Stalder and Schmid 2006). Therefore, we included the degree of having chosen one's most desired occupation in our analysis as a proxy to control for the effect of subjective mismatches, measured on a

Table 1 Items measuring four directions of drop-out intention

Direction of drop-out intention	Item
Upwards	I want to quit training to study at university (including dual university or university of applied sciences)
Horizontal (company change)	I want to change my training company
Horizontal (occupation change)	I want to change my training occupation
Downwards	I want to work without any training

five-level Likert scale (0 = strongly disagree; 4 = very high interest). Lastly, among competence factors, mathematical capabilities are crucial in successful vocational training (Abele 2014; Dietzen et al. 2014; Frank et al. 2017; Krötz 2023; Holtmann and Solga 2023; Nickolaus et al. 2009; Seeber 2014). However, due to potential collinearity problems in regression analysis when considering the correlation between mathematics scores and economics competence, we opted to include mathematical interest as an essential factor to be controlled, measured on a five-level Likert scale (0 = no interest; 4 = completely very high interest). All these control variables were collected at the beginning of the training (T0).

Analytical procedure

The presented study investigates the impact of vocational competence on drop-out intention throughout vocational training. Vocational competence is delineated into two dimensions: domain-linked competence (first independent variable) and domain-specific competence (second independent variable), while drop-out intention is the dependent variable. In our longitudinal study, control variables collected only once at T0 are treated as fixed predictors over time. To capture the temporal sequence of effects, we ensured that measurements of vocational competence always preceded those of dropout intention. This temporal ordering enables an exploration of how variations in vocational competence at an earlier time point may be associated with subsequent levels of dropout intention. The design encompasses three groups of effect relationships: (A) T0 → T1, (B) T1 → T2, (C) T0 → T2. This design allows for the examination of short- and long-term effects of vocational competence on trainees' dropout directions at different time intervals.

We conducted ordinal logistic regression analyses to examine four directions of dropout intention within each group of temporal effect relationships (A, B, C). This resulted in a total of 4*3 rounds of regression analyses. In ordinal logistic regression, the dependent variable is ordinal, indicating an explicit ordering in the categories. For instance, participants in this study were asked to rate their intention to dropout on a five-point Likert scale. By employing cumulative events for the log of the odds computation, where the coefficients of predictors (slope) remain constant across all categories while the intercepts vary for each category, ordinal logistic models consider the probability of an event and all events that are below the focal event in the ordered hierarchy. For instance, the event of interest in ordinal logistic regression in this study is to obtain a dropout intention rating equal to j or less than j . Thus, the log of odds for the probability of intention rating is computed in R as follows:

$$\text{logit}[P(Y \leq j)] = \log[P(Y \leq j)P(Y > j)] = \alpha_j - \beta X, j \in [1, J - 1]$$

To address the issue of missing values, we employed multiple imputation by generating 5 imputed datasets with 10 iterations for each imputed dataset. This approach involves generating multiple replacement values for each missing observation in the dataset. Multiple imputation is particularly useful in preserving the variability and uncertainty associated with missing data and can lead to more robust and reliable statistical inferences compared to single imputation methods or listwise deletion (Böwing-Schmalenbrock and Jurczok 2012).

Results

Correlations

Before performing the regression analyses, we conducted a check for collinearity among the independent variables. The results revealed tolerance values ranging from 0.810 to 0.986, with variance inflation factors below 1.2. These findings indicate that the estimated coefficients are stable and reliable in the resulting regression models. Further details of this collinearity check can be found in Table 7 in the Appendix. As a preliminary step, we examined the correlations between the predictor variables and drop-out intention (see Table 8 in the Appendix). The results concerning the control variables indicate that, considering drop-out intention at T1, there is a positive correlation between gender (0, female; 1, male) and the intention to drop out upward ($r=0.101$, $p=0.033$) and to change training company ($r=0.108$, $p=0.023$). Additionally, there is a positive correlation between age and the drop-out intention to change the training company ($r=0.149$, $p=0.002$), as well as between trainees' educational level and upward drop-out intention ($r=0.126$, $p=0.008$). Conversely, desired occupation correlates significantly negatively with all four drop-out directions. For drop-out intention at T2, desired occupation continues to correlate significantly negatively with all four drop-out directions. Positive correlations between gender and all four drop-out directions at T2 indicate a stronger drop-out intention among male trainees in the final training year. Additionally, age correlates positively with the intention to drop out upward ($r=0.131$, $p=0.006$) and to change company ($r=0.125$, $p=0.008$). Furthermore, mathematics interest correlates negatively with the drop-out intention to change the occupation ($r=-0.116$, $p=0.014$). In relation to vocational competence, Domain-specific competence at T0 correlates negatively with the intention to drop out downward both at T1 ($r=-0.119$, $p=0.012$) and at T2 ($r=-0.112$, $p=0.018$). Additionally, it correlates negatively with the intention to change training occupation at T2 ($r=-0.104$, $p=0.028$). Furthermore, Domain-specific competence at T1 correlates negatively with the intention to drop out downward at T1 ($r=-0.136$, $p=0.004$).

We also examined the correlation among predictors, as detailed in Table 9 in the Appendix. Consistent with theoretical assumptions, domain-linked and domain-specific dimensions of vocational competence at T0 and T1 exhibited significant correlations with each other, ranging from weak to medium effect sizes. The correlation between these two dimensions at T1 ($r=0.253$) is stronger than T0 ($r=0.121$). Additionally, variables such as desired occupation and math interest showed significant correlations with both dimensions of vocational competence, also ranging from weak to medium effect sizes.

Ordinal regression analysis

A total of 12 rounds of ordinal logistic regressions were conducted to explore the influence of two dimensions of vocational competence on four directions of dropout intention, while controlling for sociodemographic and individual characteristics. In five out of the 12 rounds, vocational competence emerged as a statistically significant predictor of dropout intention. Specifically, Table 2 presents the relevant findings of the ordinal logistic regression analyses for the temporal effect relationship between T0 and T1,

Table 2 Ordinal logistic regressions for four directions of drop-out intention (A: T0-T1)

	Dependent variable: dropout intention			
	Upward	Company	Occupation	Downward
Predictors				
Gender (0,female; 1,male)	0.558*	0.386	0.111	0.448
Age	- 0.083	0.111*	- 0.041	0.005
Language	- 0.036	0.261	- 0.013	0.390
Educational level	0.481*	0.056	- 0.119	- 0.136
Math interest	- 0.069	0.030	- 0.048	- 0.024
Desired occupation	- 0.360***	- 0.389***	- 0.529***	- 0.390***
dlt0	0.197*	0.088	0.080	0.068
dst0	- 0.176	- 0.023	- 0.141	- 0.293*
Intercepts				
0 1	0.283	3.039*	- 1.314	1.143
1 2	0.548	3.381**	- 1.090	1.416
2 3	0.864	3.570**	- 0.910	1.528
3 4	1.230	4.247**	- 0.366	1.904
Model fits				
Residual Deviance	497.1615	660.6432	638.5042	430.4717
AIC	521.1615	684.6432	662.5042	454.4717
p-value of Omnibus Test	1	0.49	0.64	0.35

One-tailed p-value for domain-linked and domain-specific competence

d| domain-linked competence, ds domain-specific competence

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

indicating that vocational competence significantly contributes to the prediction of both upward and downward dropout intention.

The last row of the table represents the Omnibus Test for the overall proportional odds assumption, a prerequisite in an ordinal logistic regression model assuming slope remains constant across all answer categories. A p-value greater than 0.05 suggests no evidence against the proportional odds assumption overall. In all four regression models for the effect relationship between T0 and T1, this prerequisite is fulfilled. Regarding dropout intention downward, the coefficient estimate of domain-specific competence (-0.293, $p < 0.05$) indicates that at the beginning of the training for trainees whose domain-specific competence increases by one unit, the probability of having the lowest intention to dropout downwards in the first year in log odds (versus being in categories more likely to dropout downwards) increase by 0.293 points. Or in simpler terms, trainees with lower domain-specific competence at the beginning of the training are more likely to dropout downwards in the first year. Similarly, holding everything else constant, an increase in the value of desired occupation by one unit increases the expected probability of belonging to the lowest category dropout downward at T1 in log odds by 0.39 (versus being more likely to dropout). The intercept for the transition from level 0 to level 1 denotes the baseline odds of moving from the lowest category to the next higher category of the ordinal outcome variable when all predictors are at 0 or their reference level. Similarly, the intercept for the transition from level 1 to level 2 represents the baseline odds of moving from the second-lowest category to the next higher category. Likewise, the intercepts for

transitions between other levels signify the baseline odds of transitioning from one category to the next higher category. Unlike other forms of regression, ordinal logistic regression models have multiple intercepts, one for each transition from one category to the next higher category. In the case of the regression model for dropout downward, none of the intercept coefficients are significant (as indicated by high p -values above 0.05), which means all intercepts are not significantly different from zero when all the predictors of dropout downward are set to zero. Thus, the estimated model can be written as:

$$\begin{aligned}\text{Logit}(P(\text{dropout downward } T1 \leq 1)) &= 1.143(\text{n.s.}) - (-0.293 \text{ domain-specific competence } T0) - (-0.390 \text{ desired occupation}) \\ \text{Logit}(P(\text{dropout downward } T1 \leq 2)) &= 1.416(\text{n.s.}) - (-0.293 \text{ domain-specific competence } T0) - (-0.390 \text{ desired occupation}) \\ \text{Logit}(P(\text{dropout downward } T1 \leq 3)) &= 1.152(\text{n.s.}) - (-0.293 \text{ domain-specific competence } T0) - (-0.390 \text{ desired occupation}) \\ \text{Logit}(P(\text{dropout downward } T1 \leq 4)) &= 1.904(\text{n.s.}) - (-0.293 \text{ domain-specific competence } T0) - (-0.390 \text{ desired occupation})\end{aligned}$$

Regarding dropout intention upward, the coefficient estimate of domain-linked competence (0.197, $p < 0.05$) suggests that at the beginning of the training for trainees whose domain-linked competence increases by one unit, the likelihood of being in category lowest intention to dropout upwards in the first year (versus being in categories more likely to dropout upwards) decreases by 0.197 points in log odds. In simpler terms, this means that higher domain-linked competence at T0 is associated with an increased likelihood of dropout intention upward in the first year. Additionally, predictors such as educational level also contribute to dropout upward at T1, while desired occupation has a negative effect on the intention to dropout upwards at T1. Furthermore, male trainees exhibit a higher tendency to dropout upwards compared to female trainees in the first year. The estimated model equations are as follows:

$$\begin{aligned}\text{Logit}(P(\text{dropout upward } T1 \leq 1)) &= 0.283(\text{n.s.}) - (0.197 \text{ domain-linked competence } T0) - (-0.360 \text{ desired occupation}) - (0.558 \text{ gender}) \\ \text{Logit}(P(\text{dropout upward } T1 \leq 2)) &= 0.548(\text{n.s.}) - (0.197 \text{ domain-linked competence } T0) - (-0.360 \text{ desired occupation}) - (0.558 \text{ gender}) \\ \text{Logit}(P(\text{dropout upward } T1 \leq 3)) &= 0.864(\text{n.s.}) - (0.197 \text{ domain-linked competence } T0) - (-0.360 \text{ desired occupation}) - (0.558 \text{ gender}) \\ \text{Logit}(P(\text{dropout upward } T1 \leq 4)) &= 1.230(\text{n.s.}) - (0.197 \text{ domain-linked competence } T0) - (-0.360 \text{ desired occupation}) - (0.558 \text{ gender})\end{aligned}$$

Results of ordinal logistic regression for four directions of dropout intention concerning the effect relationship between T1 and T2 are summarized in Table 3. A significant p -value (typically < 0.05) of Omnibus Test indicates evidence against the proportional odds assumption for that particular predictor. However, these tests have been criticized for having a tendency to reject the null hypothesis (that the sets of coefficients are the same), and hence, indicate that there the parallel slopes

Table 3 Ordinal logistic regressions for four directions of drop-out intention (B: T1-T2)

	Dependent variable: dropout intention			
	Upward	Company	Occupation	Downward
Predictors				
Gender (0,female; 1,male)	0.530	0.563*	0.948**	0.787*
Age	0.111	0.104	− 0.033	0.111
Language	0.118	0.454	0.458	0.530
Educational level	0.073	− 0.314	− 0.364*	− 0.435*
Math interest	− 0.062	− 0.159	− 0.222*	− 0.121
Desired occupation	− 0.401***	− 0.420***	− 0.586***	− 0.345**
dlt1	0.005	− 0.077	0.162	0.085
dst1	0.053	− 0.029	− 0.149	− 0.322**
Intercepts				
0 1	3.590*	1.732	− 0.617	2.726
1 2	3.989**	2.061	− 1.190	3.124
2 3	4.222**	2.538	− 0.864	3.551*
3 4	4.811**	3.224*	− 0.087	4.265**
Model fits				
Residual Deviance	441.7418	637.1022	576.4302	440.1219
AIC	465.7418	661.1022	600.4302	464.1219
p-value of Omnibus Test	0.02	0.01	0.28	0.3

One-tailed p-value for domain-linked and domain-specific competence

d| domain-linked competence, ds domain-specific competence

p < 0.05; ** p < 0.01; *** p < 0.001

assumption does not hold, in cases where the assumption does hold (see Harrell 2001, p. 335). Thus, we proceeded with our ordinal logistic regression analysis despite the violation of the proportional odds assumption. Regarding the relationship between T1 and T2, the findings from Table 3 indicate that during the midpoint of the training period, trainees with higher domain-specific competence are more inclined to have lower odds of considering dropout downwards in the final year of training. However, the impact of vocational competence at T1 on the other three directions of dropout intention at T2 is not statistically significant.

Consequently, the estimated model equations, with vocational competence as a significant predictor, can be summarized as follows:

$$\begin{aligned} \text{Logit}(P(\text{dropout downward } T2 \leq 1)) &= 2.726(\text{n.s.}) - (-0.322 \text{ domain-specific competence } T1) - (0.787 \text{ gender}) - (-0.435 \text{ educational level}) - (-0.345 \text{ desired occupation}) \\ \text{Logit}(P(\text{dropout downward } T2 \leq 2)) &= 3.124(\text{n.s.}) - (-0.322 \text{ domain-specific competence } T1) - (0.787 \text{ gender}) - (-0.435 \text{ educational level}) - (-0.345 \text{ desired occupation}) \\ \text{Logit}(P(\text{dropout downward } T2 \leq 3)) &= 3.551(\text{n.s.}) - (-0.322 \text{ domain-specific competence } T1) - (0.787 \text{ gender}) - (-0.435 \text{ educational level}) - (-0.345 \text{ desired occupation}) \\ \text{Logit}(P(\text{dropout downward } T2 \leq 4)) &= 4.265(\text{n.s.}) - (-0.322 \text{ domain-specific competence } T1) - (0.787 \text{ gender}) - (-0.435 \text{ educational level}) - (-0.345 \text{ desired occupation}) \end{aligned}$$

For the long-term relationship between T0 and T2, the findings presented in Table 3 suggest that trainees with higher domain-specific competence at the onset of training

have lower odds of expressing an intention to dropout downwards or to switch training occupations in the final year of training. However, the enduring impact of vocational competence at the commencement of training on the other two directions of dropout intention is not statistically significant.

Based on the estimated coefficients provided in Table 4, the model equations where vocational competence serves as a significant predictor can be expressed as follows:

$$\text{Logit}(P(\text{dropout downward } T2 \leq 1)) = 2.506(\text{n.s.}) - (0.307 \text{ domain-specific competence}) - (0.772 \text{ gender}) - (0.588 \text{ language}) - (-0.445 \text{ educational level}) - (-0.348 \text{ desired occupation})$$

$$\text{Logit}(P(\text{dropout downward } T2 \leq 2)) = 2.905(\text{n.s.}) - (0.307 \text{ domain-specific competence}) - (0.772 \text{ gender}) - (0.588 \text{ language}) - (-0.445 \text{ educational level}) - (-0.348 \text{ desired occupation})$$

$$\text{Logit}(P(\text{dropout downward } T2 \leq 3)) = 3.335(\text{n.s.}) - (0.307 \text{ domain-specific competence}) - (0.772 \text{ gender}) - (0.588 \text{ language}) - (-0.445 \text{ educational level}) - (-0.348 \text{ desired occupation})$$

$$\text{Logit}(P(\text{dropout downward } T2 \leq 4)) = 4.054(\text{n.s.}) - (0.307 \text{ domain-specific competence}) - (0.772 \text{ gender}) - (0.588 \text{ language}) - (-0.445 \text{ educational level}) - (-0.348 \text{ desired occupation})$$

Table 4 Ordinal logistic regressions for four directions of drop-out intention (C: T0-T2)

	Dependent variable: dropout intention			
	Upward	Company	Occupation	Downward
Predictors				
Gender (0,female; 1,male)	0.558	0.563*	0.948**	0.787*
Age	0.113	0.104	- 0.033	0.111
Language	0.105	0.454	0.458	0.530
Educational level	0.106	- 0.314	- 0.364*	- 0.435*
Math interest	- 0.044	- 0.159	- 0.222*	- 0.121
Desired occupation	- 0.396**	- 0.420***	- 0.586***	- 0.345**
dlt0	- 0.016	- 0.077	0.162	0.085
dst0	- 0.044	- 0.029	- 0.149	- 0.322**
Intercepts				
0 1	3.792*	1.732	- 0.617	2.726
1 2	4.191**	2.061	- 1.190	3.124
2 3	4.425**	2.538	- 0.864	3.551*
3 4	5.013**	3.224*	- 0.087	4.265**
Model fits				
Residual Deviance	441.8212	637.1022	576.4302	440.1219
AIC	465.8212	661.1022	600.4302	464.1219
p-value of Omnibus Test	0.02	0	0.28	0.3

One-tailed p-value for domain-linked and domain-specific competence

d/ domain-linked competence, ds domain-specific competence

p < 0.05; ** p < 0.01; *** p < 0.001

Discussion

In the presented study, our objective is to explore the influence of trainees' vocational competence development on their drop-out intentions throughout their vocational training. In addition to considering several known factors that are theoretically or empirically linked to drop-out intention, such as educational level, mathematics interest, and desired occupation, our primary focus is on understanding the causal relationship between vocational competence, assessed through domain-linked and domain-specific dimensions, and four directions of drop-out intention. To achieve this, we employed a longitudinal design involving 458 industrial management trainees who were assessed and surveyed at the initial, midterm, and final stages of their training. By conducting longitudinal analyses with lagged predictors, we were able to examine the correlations between competence and dropout intention at specific time points (T0-T1, T1-T2, T0-T2). This temporal order allowed us to analyze the effects of domain-linked and domain-specific competence over different time spans. This approach enables us to derive interventions tailored to the distinct phases of training, thereby enhancing our ability to support trainees in managing and potentially reducing their drop-out intentions throughout the vocational training process. Considering the ordinal structure of the dropout intention data, we employed ordinal logistic regression to investigate the relationship between competence and dropout intention across three time series (T0-T1, T1-T2, T0-T2).

In all three time series, our analysis reveals that lower domain-specific competence is associated with an increased intention among trainees to drop out downward. However, we did not observe any significant effect of domain-linked competence on trainees' intention to drop out downward. As a result, Hypothesis H1a is not confirmed, while Hypothesis H2a is supported by our findings. Additionally, we observed that the levels of domain-specific competence at the outset of training influence trainees' intention to change their occupation during the final year of training. Again, we did not find any significant effect of domain-linked competence on trainees' intention to change their training occupation. Consequently, Hypothesis H2b is partially confirmed, while Hypothesis H1b is not supported by our findings. These results suggest the long-term impact of job- and task-specific problem-solving competences acquired during the initial semester of training. Regarding the intention to change training company (H1c and H2c), we did not find any significant effects of both domain-linked and domain-specific dimensions of vocational competence. Therefore, neither H1c nor H2c is confirmed. Regarding the intention to drop out upward, we found that domain-linked competence during the first year of training emerged as a significant predictor of the intention to pursue higher education outside of vocational education and training (VET) during the midterm of training. However, we did not observe any significant effect of domain-specific competence on trainees' dropout upward intention. Thus, H1d is partially confirmed, while H2d is not supported by our findings.

The results from our 12 rounds of regression analyses did not entirely align with our expectations. Specifically, while we tested for two dimensions of vocational competence, only one dimension, domain-specific competence, emerged as a more relevant predictor of later drop-out intention. This finding can be attributed to several factors: Firstly, vocational training curriculum may predominantly focus on developing domain-specific skills and knowledge relevant to the specific occupation. As a result, trainees may gradually prioritize and rely more on domain-specific competence as they progress through the training program. Secondly, as theoretically assumed for development of vocational competence, over time, trainees' experiences and practice in real-world vocational settings may lead to a contextualization of their competence. This means that while domain-linked competence may be more prevalent initially, trainees increasingly integrate and apply domain-specific skills and knowledge in practical vocational contexts, making domain-specific competence more relevant for dropout intention. Thirdly, the tasks and challenges encountered in vocational training may become increasingly complex as trainees progress. In such cases, domain-specific competence, which directly addresses the specific requirements of the vocational tasks, may become more critical for trainees to navigate and succeed in their training, influencing their dropout intentions.

Among the four directions of drop-out intention, dropping out downwards was found to be best predicted by vocational competence. Trainees lacking domain-specific competence tend to express an intention to leave the vocational education and training (VET) system without qualifications, rather than changing their training occupation, training company, or pursuing higher education outside of VET. There are several potential ways in which vocational competence deficits could be associated with drop-out intention. One possible explanation is a direct association between domain-specific competence and drop-out because of failing the graduation exam, which is a one-time extreme situation occurring only at the end of training. However, in our study, this scenario is less likely to apply because this situation primarily affects drop-out behavior rather than intention, and it dichotomizes vocational competence into pass/fail categories rather than considering it as a continuous variable. Another possibility is that domain-specific competence correlates with drop-out intention through mediators such as trainers or teachers. In vocational education, competence levels are often reflected in learning activities such as exams and homework, and trainees receive feedback on their competence through grades from vocational schools or comments and advice from trainers. This feedback could influence their intention to drop out. A third relationship could involve moderation by trainees' lack of belief in their capacity, also known as self-efficacy. This deficit in self-efficacy might moderate the actual choices a person is most likely to make regarding dropout intention. However, it's important to note that these last two types of causality were not tested in our study design and could be avenues for further research to explore the complex relationship between vocational competence and drop-out intention in vocational education and training settings.

In addition to the results regarding vocational competence, our study confirmed existing evidence on the significant roles of trainees' occupational expectations, educational level, age, and gender in drop-out intention (see, for example, Böhn and Deutscher 2022). Desired Occupation consistently showed a negative correlation with all directions of drop-out intention, indicating that drop-out intention decreases when trainees perceive they are being trained in their most desired occupation. Furthermore, male trainees exhibited more fluctuation in their intentions during the final training year, displaying a stronger inclination to leave or change their current vocational training. The findings regarding educational level are particularly intriguing. While trainees with a higher educational level were more likely to express intentions to drop out upwards during the first year of training, a higher educational level decreased drop-out intentions during the final training year. This suggests that as the training progresses, educational level transitions from being a factor associated with ambition to one associated with stability and retention in the program.

Putting aside the influencing factors, if we solely observe the data of dropout intention, we notice an increasing trend in dropout intention with the increase in the standard deviation. This suggests that as the training progresses, variability and differentiation among trainees become more apparent, highlighting the importance of investigating the factors behind this trend and providing interventions to support trainees. Despite the increased dropout intention and its higher standard deviation, the overall dropout intention remains relatively low across the three years of training. This aligns with data published by BIBB (2022), indicating that occupations such as bank clerks (Bürokaufmann/-frau) and industrial trainees (Industriekaufmann/-frau) belong to training occupation groups with lowest dropout rates. However, this also limits the generalizability of the presented results. Focusing on occupations with low dropout rates may not fully capture the range of dropout-related dynamics observed in occupations with higher dropout rates. Additionally, the limited number of dropout cases in the chosen occupation may restrict the variability in dropout intention scores, potentially affecting the statistical power and generalizability of the results. Another reason for the limited generalizability is the high specificity of domains. Different domains may have varying levels of the two dimensions of vocational competence at each training stage, leading to different patterns of effects on dropout intention. Therefore, it is essential to consider these factors when analyzing dropout phenomena and interpreting the results. Furthermore, in our study, we followed trainees who participated in all three surveys, meaning that trainees who dropped out before the final year of training were not represented in the sample. According to BIBB (2022), the majority of dropouts occur early in the training process. Therefore, this methodological decision has two main implications: (a) potential sampling bias: focusing only on trainees who completed all three surveys may introduce sampling bias because individuals who persist through the entire training period are overrepresented in the sample. This could lead to an incomplete understanding of dropout dynamics, as the experiences of early dropouts are not captured. (b) limited understanding of early

dropout factors: by excluding early dropouts from the sample, our study may limit the understanding of factors influencing dropout intentions in the initial stages of vocational training. Early dropout may be influenced by different factors compared to dropout later in the training process. However, our study provides valuable insights into the experiences and perspectives of trainees who persisted through the later stages of their training. This temporal focus allows for a deeper exploration of factors influencing dropout intention during the later stages of vocational training. Future research could address these limitations by specifically targeting and investigating the factors influencing early dropout, thus providing a more comprehensive understanding of the challenges faced by trainees in the initial stages of their vocational training. Another limitation of the study is its research scope. We solely focus on cognitive factors during vocational training, neglecting non-cognitive factors such as trainees' sociodemographic background, personal plans, training conditions, motivation, and interest. Furthermore, among cognitive factors, we only investigate vocational specialized competence, overlooking transversal competencies like social competence. While this specialized focus enhances the precision of definition, modeling, and measurement, it also confines the scope of the research question. Although variables such as educational level, gender, and interest are controlled for, the influence of occupational-related structures on dropout is complex and diverse. Therefore, future studies should refine research methods, employing techniques such as multilevel design to examine nested structures and mediation- or moderation analysis to investigate contrasting or competing effects, or latent growth model to understand the individual variability in growth trajectories of dropout intention over time.

The practical significance of these results lies in their relevance for designing training programs and interventions to support apprentices in successfully completing their training. Some practical implications could include:

1. Promotion of domain-specific competence: Training programs could aim to strengthen apprentices' domain-specific competence, especially at the beginning of their training. This could help reduce dropout rates by better preparing apprentices for the requirements of their vocational profession.
2. Support for the development of domain-linked competence: It may be beneficial to train apprentices not only in job-specific skills but also in general, transferable skills such as mathematical and language competence. This could not only help them successfully complete their training but also increase their vocational flexibility and adaptability (dropout intention upward). An open question here is whether vocational flexibility and adaptability, beneficial for individuals, are also advantageous for the vocational training system.
3. Early identification of risk factors: By identifying apprentices with lower domain-specific competence at the beginning of their training, targeted support measures could be developed to address potential risk factors for dropout. This could take the form of additional support through mentoring, tutoring, or individualized assistance.

4. Counseling and career planning: Career advisors and training managers could use the results of this study to support apprentices in career planning and highlight the long-term prospects and benefits of successfully completing their training. Additionally, they could provide guidance in decision-making regarding potential further education or career changes.

Additionally, a differentiated analysis of the temporal dynamics of relationships between vocational competence and dropout intention contributes to the development of effective strategies to support apprentices and achieve long-term positive training outcomes. For example, domain-specific competence at T0 negatively correlates with the intention to drop out without qualifications, targeted interventions could be developed to support apprentices in the early stages of their training and reduce the risk of dropout. Concerning long-term effects, for example, domain-linked competence at T0 positively correlates with the intention to drop out to attend university, this may indicate that promoting general transferable skills early in training can have long-term positive effects (for individuals).

Appendix

See Fig. 1 and Table 5, 6, 7, 8 and 9

Initial situation:

Mrs. Kenk tells you about successful talks with a new customer from abroad. The American construction company "Miller Ltd." would like to use bathtubs from the series "Star" in new buildings in the future. This is a good opportunity for Ceraforma Ceramics AG to promote exports.

1. Since the last price calculation for the product was more than a year ago and the prices have changed, Mrs. Kenk asks you to use the following values to determine the net sales price for a "Star" corner bath, from Ceraforma's point of view, using the preliminary calculation.

Target for profit	8 %
Administrative overhead rate	13 %
Manufacturing material	1.000 EUR
Material overhead rate	16 %
Manufacturing wages	80 EUR
Sales overhead rate	12,5 %
Manufacturing overhead rate	14,0 %

Calculate the following values:

- a.) Material costs: _____
- b.) Manufacturing costs: _____
- c.) Cost Price: _____
- d.) Net sales price per piece: _____

Fig. 1 Example of domain-specific items from the competence test by Klotz (2015)

Table 5 Sample characteristics

Aspect	Coding	Frequency	Percentage	Valid Percentage	Cumulated Percentage
Gender n = 455	Female	291	63.5	64	64
	Male	164	35.8	36	100
Educational Level (highest school leaving certificate) n = 456	Below Secondary school (Hauptschulabschluss)	1	0.2	0.2	0.2
	Secondary school certificate (Mittlere Reife)	91	19.9	20.0	20.2
	Advanced technical college (Fachhochschulreife)	133	29.0	29.2	49.3
	General higher education certificate (allgemeine Hochschulreife/Abitur)	231	50.4	50.7	100
Language(s) (spoken at home) n = 453	Only German	344	75.1	75.9	75.9
	More than German	101	22.1	22.3	98.2
	Only other than German	8	1.7	1.8	100
Company Size (Number of employees) n = 438	1–5	2	0.4	0.5	0.5
	6–10	2	0.4	0.5	0.9
	11–20	9	2.0	2.1	3.0
	21–50	30	6.6	6.8	9.8
	51–100	49	10.7	11.2	21.0
	101–250	95	20.7	21.7	42.7
	251–500	105	22.9	24.0	66.7
	501–1000	68	14.8	15.5	82.2
> 1000	78	17.0	17.8	100	

N maximum = 458

Table 6 Item statistics

Scale/Factor	Item/Indicator	Mean value	Standard deviation	N
Person-Environment Fit Factors				
Maths interest	My interest in the following topics is... Maths: [i]	2.19	1.154	455
Desired Occupation	My training course was my desired occupation at the time I chose it	3.04	0.981	453
Drop-out Intention at T0				
Upwards	I want to quit training to study at university (including dual university or university of applied sciences)	0.19	0.568	435
Horizontal (Company)	I want to change my training company	0.17	0.543	438
Horizontal (Occupation)	I want to change my training occupation	0.19	0.587	436
Downwards	I want to work without any training	0.10	0.473	432
Drop-out Intention at T1				
Upwards	I want to quit training to study at university (including dual university or university of applied sciences)	0.42	1.115	446
Horizontal (Company)	I want to change my training company	0.59	1.259	446
Horizontal (Occupation)	I want to change my training occupation	0.62	1.323	446
Downwards	I want to work without any training	0.37	1.068	446
Drop-out Intention at T2				
Upwards	I want to quit training to study at university (including dual university or university of applied sciences)	0.31	0.954	445
Horizontal (Company)	I want to change my training company	0.53	1.168	444
Horizontal (Occupation)	I want to change my training occupation	0.47	1.118	447
Downwards	I want to work without any training	0.30	0.905	445

Original response options: 0 = strongly disagree, 1 = mostly disagree, 2 = partly agree, 3 = mostly agree, 4 = completely agree. [i] = response options: 0 = no interest, 1 = low interest, 2 = medium interest, 3 = high interest, 4 = very high interest

Table 7 Multicollinearity coefficients table

	T0		T1	
	Tolerance	VIF	Tolerance	VIF
Model 1				
Gender	0.983	1.017	0.982	1.018
Age	0.863	1.159	0.862	1.161
Educational Level	0.891	1.123	0.889	1.125
Language	0.963	1.039	0.962	1.039
Model 2				
Gender	0.977	1.023	0.977	1.024
Age	0.844	1.184	0.843	1.186
Educational Level	0.872	1.147	0.871	1.149
Language	0.958	1.043	0.958	1.044
Desired occupation	0.923	1.083	0.924	1.083
Math interest	0.983	1.017	0.983	1.017
Model 3				
Gender	0.955	1.047	0.953	1.049
Age	0.843	1.186	0.836	1.196
Educational level	0.844	1.185	0.813	1.230
Language	0.958	1.044	0.950	1.052
Desired occupation	0.921	1.086	0.922	1.084
Math interest	0.958	1.043	0.956	1.046
Domain-linked competence	0.979	1.021	0.886	1.129
Domain-specific competence	0.910	1.099	0.870	1.150

Table 8 Spearman correlations between drop-out intention and its predictors

	T1			T2		
	Upwards	Company	Downwards	Upwards	Company	Downwards
Gender	Correlation .101*	.108*	.067	.121*	.128**	.114*
	Sig. .033	.023	.161	.011	.007	.016
	N 444	443	443	442	441	442
Age	Correlation .033	.149**	.073	.131**	.125**	.090
	Sig. .491	.002	.124	.006	.008	.057
	N 446	446	446	445	447	445
Language	Correlation -.009	.076	.068	.022	.116*	.122*
	Sig. .843	.112	.152	.639	.015	.010
	N 442	441	441	440	439	440
Educational level	Correlation .126**	.079	-.013	.074	-.044	-.081
	Sig. .008	.098	.777	.118	.362	.089
	N 444	444	444	443	442	443
Math interest	Correlation -.055	-.021	-.043	-.040	-.093	-.079
	Sig. .245	.659	.369	.403	.051	.099
	N 443	443	443	442	441	442
Desired occupation	Correlation -.160**	-.210**	-.153**	-.172**	-.203**	-.120*
	Sig. .001	.000	.001	.000	.000	.011
	N 441	441	441	440	439	440
dIT0	Correlation .068	.007	-.019	-.007	-.069	-.012
	Sig. .153	.880	.687	.885	.147	.804
	N 446	446	446	445	444	445

Table 8 continued

	T1				T2			
	Upwards	Company	Occupation	Downwards	Upwards	Company	Occupation	Downwards
d1 T1	Correlation .043	.012	-.008	-.072	.008	-.063	.015	-.043
	Sig. .368	.801	.871	.128	.862	.188	.749	.368
	N 446	446	446	446	445	444	447	445
ds T0	Correlation -.041	.003	-.082	-.119*	-.013	-.072	-.100*	-.112*
	Sig. .387	.948	.084	.012	.790	.131	.034	.018
	N 446	446	446	446	445	444	447	445
ds T1	Correlation .091	.057	.020	-.075	.048	-.025	-.067	-.136**
	Sig. .054	.233	.680	.111	.308	.602	.160	.004
	N 446	446	446	446	445	444	447	445

All correlation coefficients in this table are Pearson correlation coefficients

d1 domain-linked competence, ds domain-specific competence

*p < 0.05; ** p < 0.01

Table 9 Correlations among predictors

	Gender ¹	Age	Language ¹	Educational level ¹	Math interest	Desired occupation	dIT0	dIT1	dsT0	dsT1
Gender ¹	Correlation	1					0.020	0.003	0.131**	0.122**
	Sig.			0.092*	0.009	-0.122*	0.673	0.955	0.005	0.009
	N	455		0.049	0.853	0.010	455	455	455	455
Age	Correlation	1		0.314**	-0.046	-0.202**	-0.001	0.131**	0.031	0.115*
	Sig.			0.000	0.325	0.000	0.982	0.005	0.513	0.014
	N	458		456	455	453	458	458	458	458
Language ¹	Correlation		1	-0.018	0.025	-0.039	-0.018	-0.052	0.007	-0.077
	Sig.			0.699	0.604	0.411	0.703	0.272	0.883	0.100
	N		453	452	451	449	453	453	453	453
Educational level ¹	Correlation			1	-0.015	-0.224**	0.079	0.269**	0.188**	0.214**
	Sig.			0.000	0.746	0.000	0.093	0.000	0.000	0.000
	N			456	454	452	456	456	456	456
Math interest	Correlation				1	0.097*	0.083	0.093*	0.172**	0.154**
	Sig.				0.924	0.325	0.417	0.077	0.000	0.001
	N				453	455	451	455	455	455
Desired occupation	Correlation					1	0.027	-0.001	-0.004	-0.059
	Sig.					0.011	0.568	0.981	0.940	0.206
	N					451	449	453	453	453
dIT0	Correlation						1	0.187**	0.121**	0.113*
	Sig.						0.983	0.000	0.009	0.015
	N						458	458	458	458
dIT1	Correlation							1	0.109*	0.253**
	Sig.							0.459	0.019	0.000
	N							455	458	458

Table 9 continued

	Gender ¹	Age	Language ¹	Educational level ¹	Math interest	Desired occupation	dITO	dIT1	dsTO	dsT1
dsTO	Correlation 0.137**	0.031	0.001	0.195**	0.172**	-0.004	0.121**	0.109*	1	0.282**
	Sig. 0.003	0.513	0.988	0.000	0.000	0.940	0.009	0.019		0.000
	N 455	458	453	456	455	453	458	458	458	458
dsT1	Correlation 0.137**	0.115*	-0.066	0.229**	0.154**	-0.059	0.113*	0.253**	0.282**	1
	Sig. 0.003	0.014	0.160	0.000	0.001	0.206	0.015	0.000	0.000	
	N 455	458	453	456	455	453	458	458	458	458

We excluded the correlation among age, gender, and language because it lacks logical relevance in our analysis

dI domain-linked competence, ds domain-specific competence

*p < 0.05; ** p < 0.01

¹ spearman correlation; others pearson correlation

Abbreviation

VET Vocational education and training

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Author contributions

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Data availability

The datasets generated and analyzed during the current study are not publicly available due the fact that they constitute an excerpt of research in progress but are available from the corresponding author on reasonable request.

Declarations**Ethics approval and consent to participate**

In this non-interventional study (Survey Research), the data is completely anonymous with no personal information being collected. All subjects participated voluntarily. The participants provide their written informed consent to participate in this study. The Declaration of Helsinki was adequately addressed.

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References

- Abele S (2014) Modellierung und Entwicklung berufsfachlicher Kompetenz in der gewerblich technischen Ausbildung [Modeling and development of professional competence in industrial technical training]. Steiner, Stuttgart
- Baas M, Eulenberger J, Geier B, Kohlrusch B, Lex T, Richter M (2012) "Kleben bleiben?" Der Übergang von Hauptschüler/innen in eine berufliche Ausbildung. Eine vergleichende Analyse von "Praxisklassen" in Bayern und "Berufsstarterklassen" in Niedersachsen ["Sticking around?" The Transition of Secondary School Students to Vocational Training. A Comparative Analysis of "Praxisklassen" in Bavaria and "Berufsstarterklassen" in Lower Saxony]. *Zeitschrift für Soziale Fortschritt*, 10, forthcoming.
- Beck, K., Landenberger, M., and Oser, F. (2016). Technologiebasierte Kompetenzmessung in der beruflichen Bildung: Ergebnisse aus der BMBF-Förderinitiative ASCOT [Technology-Based Competence Measurement in Vocational Education: Results from the BMBF Funding Initiative ASCOT]. *Wirtschaft–Beruf–Ethik*, Band 32. Bielefeld: Wbv.
- Beicht, U., and Walden, G. (2013). *Duale Berufsausbildung ohne Abschluss–Ursachen und weiterer bildungsbiografischer Verlauf. Analyse auf Basis der BIBB-Übergangsstudie 2011* [Dual vocational training without a degree–Causes and further educational biography. Analysis based on the BIBB transition study 2011]. BIBB-Report, 21/13. Bonn: Bundesinstitut für Berufsbildung.
- Berweger S, Krattenmacher S, Salzmann P, Schönenberger S (2013) LiSa. Lernende im Spannungsfeld von Ausbildungserwartungen, Ausbildungsrealität und erfolgreicher Erstausbildung [LiSA. Learners in the tension between training expectations, training reality and successful initial training]. St. Gallen, CH: Pädagogische Hochschule St. Gallen, Institut Professionsforschung und Kompetenzentwicklung.
- Bessey D, Backes-Gellner U (2015) Staying within or leaving the apprenticeship system? revisions of educational choices in apprenticeship training. *Jahrbücher Für Nationalökonomie Und Statistik* 235(6):539–552. <https://doi.org/10.1515/jbnst-2015-0603>
- Böhn S, Deutscher V (2022) Dropout from initial vocational training—a meta-synthesis of reasons from the apprentice's point of view. *Educ Res Rev*. <https://doi.org/10.1016/j.edurev.2021.100414>
- Böwing-Schmalenbrock M, Jurczok A (2012) Multiple Imputation in der Praxis: Ein sozialwissenschaftliches Anwendungsbeispiel [Multiple imputation in practice: a social science application example]. Universität Potsdam.
- Brötz R, Kaiser F (2015) Berufsbildungstheoretische Konzeption der Tätigkeiten und Qualifikationen kaufmännischer Angestellter [Theoretical Conception of Activities and Qualifications of Commercial Employees in Vocational Education]. In: Brötz R, Kaiser F (eds) *Kaufmännische Berufe–Charakteristik, Vielfalt und Perspektiven*. Bertelsmann, Bielefeld, pp 49–90

- Büchle S, Feudel F (2023) Changes in Students' Mathematical Competencies at the Beginning of Higher Education Within the Last Decade at a German University. *Int J of Sci and Math Educ, Online First*. <https://doi.org/10.1007/s10763-022-10350-x>
- Bundesinstitut für Berufsbildung (2020) Datenreport zum Berufsbildungsbericht 2020. Informationen und Analysen zur Entwicklung der beruflichen Bildung [Data report referring to the report on vocational education 2020. Information and analyses on the developments of vocational education]. Bundesinstitut für Berufsbildung, Bonn
- Bundesinstitut für Berufsbildung (2021) Datenreport zum Berufsbildungsbericht 2021. Informationen und Analysen zur Entwicklung der beruflichen Bildung [Data report referring to the report on vocational education 2021. Information and analyses on the developments of vocational education]. Bundesinstitut für Berufsbildung, Bonn
- Bundesinstitut für Berufsbildung (2022) Datenreport zum Berufsbildungsbericht 2022. Informationen und Analysen zur Entwicklung der beruflichen Bildung [Data report referring to the report on vocational education 2022. Information and analyses on the developments of vocational education]. Bundesinstitut für Berufsbildung, Bonn
- Bundesministeriums der Justiz und für Verbraucherschutz (2005) *Berufsbildungsgesetz (BBiG) [VET/PET legislation]*. http://www.gesetze-iminternet.de/bundesrecht/bbig_2005/gesamt.pdf
- Callan V (2005) Why do students leave? Leaving vocational education and training with no recorded achievement. National Centre for Vocational Education Research (NCVER).
- Caruana EJ, Roman M, Hernández-Sánchez J, Solli P (2015) Longitudinal studies. *J Thoracic Dis* 7(11):E537–E540. <https://doi.org/10.3978/j.issn.2072-1439.2015.10.63>
- CEDEFOP (2016) Leaving education early: putting vocational education and training centre stage. Volume I: Investigating causes and extent. Luxembourg: Publications Office of the European Union. Cedefop research paper, 57. <https://doi.org/10.2801/773690>
- Cully, M., and Curtain, R. (2001). *Reasons for New Apprentices' Non-Completions*. Leabook: National Centre for Vocational Education Research (NCVER).
- Deutscher V, Winther E (2018) Instructional sensitivity in vocational education. *Learn Instr* 53:21–33. <https://doi.org/10.1016/j.learninstruc.2017.07.004>
- DGB-Bundesvorstand (2020) Ausbildungsreport 2020 [Training report 2020]. DGB-Bundesvorstand, Abteilung Jugend und Jugendpolitik, Berlin
- Dietzen A, Velten S, Schnitzler A, Schwerin C, Nickolaus R, Gönnerwein A, Lazar A (2014) Einfluss der betrieblichen Ausbildungsqualität auf die Fachkompetenz in ausgewählten Berufen (Aqua. Kom) [Influence of in-company training quality on professional competence in selected occupations]. Bundesinstitut für Berufsbildung, Bonn
- Ernst V, Spevacek G (2012) Verbleib von Auszubildenden nach vorzeitiger Vertragslösung. Ergebnisse der IHK-Ausbildungsumfrage 2012 [Continuance of apprentices who prematurely terminated contract. Results of the IHK training survey 2012]. Hannover: Industrie- und Handelskammer (IHK).
- Faßmann H (1998) Das Abbrecherproblem—die Probleme der Abbrecher: Zum Abbruch der Erstausbildung in Berufsbildungswerken [The dropout problem—the problems of dropouts: drop-out of initial training in vocational training centers]. Materialien aus dem Institut für empirische Soziologie Nürnberg, 1/1998. Nürnberg.
- Faßmann H, Funk W (1997) Früherkennung und Reduzierung von Abbrüchen der Berufsausbildung in Berufsbildungswerken [Early detection and reduction of dropouts in vocational training in vocational training centers]. *Mitt Arbeitsmarkt Berufsforsch* 30(2):345–355
- Feß W (1995) Schlüsselbegriffe im Kontext unserer praktischen Arbeit [Key terms in the context of our practical work]. In: Ballauf H (ed) Scheitern in Ausbildung und Beruf verhindern: Wie Jugendlichen beim Übergang Schule-Arbeitswelt wirksamer geholfen werden kann. Bertelsmann, Bielefeld, pp 24–37
- Findeisen S, Jüttler A, Neuenschwander MP, Schumann S (2022) Transition from school to work—Explaining persistence intention in vocational education and training in Switzerland. *Vocat Learn* 15(1):129–154. <https://doi.org/10.1007/s12186-021-09282-4>
- Flake R, Malin L, Middendorf L, Seyda S (2014) Qualifizierung von An- und Ungelernten: eine empirische Bestandsaufnahme der Lebenssituation und Potenziale [Qualification of semi-skilled and unskilled workers: an empirical inventory of the life situation and potentials]. *IW-Analysen*, 100.
- Frank C, Härtig H, Neumann K (2017) Schulisch erworbene Kompetenzen als Voraussetzung für berufliches Wissen gewerblich-technischer Auszubildender [Competences acquired in general education as a precondition for occupation-related knowledge of industrial-technical trainees]. *Unterrichtswissenschaft* 36:22–35. <https://doi.org/10.3262/UW1701022>
- Gelman R, Greeno JG (1989) On the nature of competence: Principles for understanding in a domain. In: Resnick LB (ed) *Knowing, learning and instruction: Essays in honor of Robert Glaser*. Erlbaum Associates, Hillsdale, NJ, pp 125–186
- Greeno JG, Riley MS, Gelman R (1984) Conceptual competence and children's counting. *Cogn Psychol* 16(1):94–143
- Greilinger A (2013) Analyse der Ursachen und Entwicklung von Lösungsansätzen zur Verhinderung von Ausbildungsabbrüchen in Handwerksbetrieben [Analysis of the causes and development of solutions to prevent training dropouts in craft businesses]. Ludwig-Fröhler-Institut, München
- Hager P (2004) The competence affair, or why vocational education and training urgently needs a new understanding of learning. *J Voc Educ Train* 56(3):409–433. <https://doi.org/10.1080/13636820400200262>
- Harell FE (2001) Regression modeling strategies: with applications to linear models, logistic regression, and survival analysis. Springer-Verlag. <https://doi.org/10.1007/978-1-4757-3462-1>
- Hartig J, Höhler J (2009) Multidimensional IRT models for the assessment of competencies. *Stud Educ Eval* 35(2–3):57–63
- Hasler P (2016) Lehrvertragsauflösungen im Schweizer Bauhauptgewerbe—Unausgeschöpftes Potenzial. Ursachen und Maßnahmen [Premature termination of contract within the Swiss construction industry—unexploited potential. Reasons and measures] [Dissertation]. University of Stuttgart.
- Hensge K, Lorig B, Schreiber D (2009) Kompetenzstandards in der Berufsausbildung. Abschlussbericht [Competence standards in vocational training. Final report]. Bonn: Bundesinstitut für Berufsbildung.
- Holtmann AC, Solga H (2023) Dropping or stopping out of apprenticeships: the role of performance- and integration-related risk factors. *Z Erzieh* 26:469–494. <https://doi.org/10.1007/s11618-023-01151-1>

- Klieme E, Hartig J, Rauch D (2008) The concept of competence in educational contexts. In: Hartig J, Klieme E, Leutner D (eds) *Assessment of competencies in educational contexts*. Hogrefe and Huber Publishers, pp 3–22
- Klotz VK (2015) Diagnostik beruflicher Kompetenzentwicklung. Eine wirtschaftsdidaktische Modellierung für die kaufmännische Domäne. [Diagnosis of professional development. A didactic modeling for the commercial domain]. Wiesbaden: Springer.
- Klotz VK, Winther E (2016) Zur Entwicklung domänenverbundener und domänenspezifischer Kompetenz im Ausbildungsverlauf. Eine Analyse für die kaufmännische Domäne [Towards the development of domain-linked and domain-specific competences during vocational educational training. An analysis for the commercial domain]. *Zeitschrift für Erziehungswissenschaft*, 19(4), 765–782. <https://doi.org/10.1007/s11618-016-0687-1>
- Klotz VK, Winther E, Festner D (2015) Modeling the development of vocational competence: a psychometric model for business domains. *Vocat Learn* 8(3):247–268. <https://doi.org/10.1007/s12186-015-9139-y>
- Krötz M, Deutscher V (2021) Differences in perception matter—How differences in the perception of training quality of trainees and trainers affect drop-out in VET. *Vocat Learn* 14:369–409. <https://doi.org/10.1007/s12186-021-09263-7>
- Krötz M, Deutscher V (2022) Drop-out in dual VET: Why we should consider the drop-out direction when analysing drop-out. *Empirical Res Voc Educ Train* 14:1–26
- Krötz M, Ma B, Deutscher V, Winther E (2022) The power of in-company training for competence development: doing one thing without neglecting the other. [under review]. Chair of Economic and Business Education—Competency Development and Training Quality, University of Mannheim.
- Krötz M (2023) The quality of in-company training—perspectives and effects. Dissertation. Mannheim.
- Lange S (2020) Vorzeitige Vertragslosungen aus der Perspektive der Auszubildenden—ein Vorschlag für einen subjektorientierten Erklärungsansatz [Premature termination of contracts from the perspective of trainees—a suggestion for a subject-oriented explanation approach]. In: Wittmann E, Frommberger D, Weyland U (eds) *Jahrbuch der Berufs- und Wirtschaftspädagogischen Forschung 2020*. Verlag Barbara Budrich, Opladen, pp 97–112
- Lehmann R, Seeber S (2007) Ausblick: Perspektiven der Kompetenzerfassung in beruflichen Bildungsgängen [Outlook: Perspectives on competence assessment in vocational training courses]. In: Lehmann R, Seeber S (eds) *ULME III. Untersuchung von Leistungen, Motivation und Einstellungen der Schülerinnen und Schüler in den Abschlussklassen der Berufsschulen*. Behörde für Bildung und Sport, Hamburg, pp 227–228
- Ma B, Krötz M, Deutscher V, Winther E (2023) Same yet different: invariance of the multidimensional construct of the vocational competence across test formats. [Manuscript submitted for publication]. Vocational and Educational Training, University Duisburg-Essen.
- Ma B, Krötz M, Deutscher V, Winther E (2024) Understanding multidimensional vocational competence dynamics: insights from a longitudinal study in the economic domain. [Manuscript submitted for publication]. Vocational and Educational Training, University Duisburg-Essen.
- Michaelis C, Findeisen S (2022) Influence of person-vocation fit on satisfaction and persistence in vocational training programs. *Front Psychol* 13(834543):1–16. <https://doi.org/10.3389/fpsyg.2022.834543>
- Michaelis C, Richter M (2022) Discontinuities in vocational education and training: the influence of early-risk factors and personality constructs on premature training termination and subsequent trajectories. *Empirical Res Voc Ed Train* 14:7. <https://doi.org/10.1186/s40461-022-00135-5>
- Ministry of Education, Culture and Science [OCW] (2022c) Kamerbrief over cijfers voortijdig schoolverlaten (VSV) 2020–2021 [Chamber letter on figures for early school leaving (ESL) 2020–2021]. <https://www.rijksoverheid.nl/documenten/kamerstukken/2022/03/14/cijfers-voortijdig-schoolverlaten-vsv-2020-2021>
- Nägele C, Neuenschwander MP (2015) Determinanten und Konsequenzen wahrgenommener Passung mit dem Lehrberuf beim Übergang in die Berufsbildung [Determinants and consequences of perceived fit with the skilled occupation during the transition to vocational training]. In: Häfeli K, Neuenschwander MP, Schumann S (eds) *Berufliche Passagen im Lebenslauf*. VS, Wiesbaden, pp 49–76 (10.1007/978-3-658-10094-0)
- National Education Report (2022) *Bildung in Deutschland 2022*. WBV, Bielefeld
- Nickolaus R, Gschwendtner T, Geißel B (2009) Betriebliche Ausbildungsqualität und Kompetenzentwicklung [Quality of in-company training and competency development]. *Bwp@ Berufs- und Wirtschaftspädagogik—online* 17, 1–20.
- Organization for Economic Cooperation and Development [OECD] (2005) The definition and selection of key competencies: executive summary. OECD, Paris
- Piening D, Hauschildt U, Rauner F (2010) Lösung von Ausbildungsverträgen aus Sicht von Auszubildenden und Betrieben [Premature termination of contract from the apprentice's and the company's point of view]. Bremen: IBB. https://www.ibb.uni-bremen.de/fileadmin/user/Publikationen/IBB_Abruchstudie_Download_oA.pdf
- Quante-Brandt E, Grabow T (2008) Die Sicht von Auszubildenden auf die Qualität ihrer Ausbildungsbedingungen: Regionale Studie zur Qualität und Zufriedenheit im Ausbildungsprozess [Trainees' perspective on the quality of their training conditions: Regional study on quality and satisfaction in the training process]. *Berichte zur beruflichen Bildung*, Bundesinstitut für Berufsbildung. Bielefeld: W. Bertelsmann Verlag.
- Rohrbach-Schmidt D, Uhly A (2015) Determinanten vorzeitiger Lösungen von Ausbildungsverträgen und berufliche Segmentierung im dualen System. Eine Mehrebenenanalyse auf Basis der Berufsbildungsstatistik [Determinants of Premature Dissolutions of Apprenticeship Contracts and Occupational Segmentation in the Dual System. A Multi-level Analysis with the German Census on Vocational Education and Training. *Kölner Zeitschrift Für Soziologie Und Sozialpsychologie* 67(1):105–135. <https://doi.org/10.1007/s11577-014-0297-y>
- Rosendahl J, Straka GA (2011) Kompetenzmodellierungen zur wirtschaftlichen Fachkompetenzangehender Bankkaufleute [Competence modelling for the economic expertise of prospective bank clerks]. *Zeitschrift Für Berufs- Und Wirtschaftspädagogik* 107(2):190–217. <https://doi.org/10.25162/zbw-2011-0011>
- Roth H (1971) *Pädagogische Anthropologie. Band 2: Entwicklung und Erziehung* [Educational Anthropology. Volume 2: Development and Education]. Hannover: Schroedel.
- Schmid E, Stalder BE (2012) Dropping out from apprenticeship training as an opportunity for change. In: Tynjala P, Stenstrom ML, Saarnivaara M (eds) *Transitions and transformations in learning and education*. Springer, Dordrecht, pp 117–130 (10.1007/978-94-007-2312-2_8)

- Schnick-Vollmer K, Berger S, Bouley F, Fritsch S, Schmitz B, Seifried J, Wuttke E (2015) Modeling the competencies of prospective business and economics teachers: professional knowledge in accounting. *Zeitschrift Für Psychologie* 223(1):24–30. <https://doi.org/10.1027/2151-2604/a0001>
- Schöngren K (2003) Lösung von Ausbildungsverträgen–schon Ausbildungsabbruch? Ergebnisse einer Befragung des Bundesinstituts für Berufsbildung [Termination of apprenticeship contracts–already a drop-out? Results of a survey by the Federal Institute for Vocational Training]. *IBV* 25:5–19
- Schuster M (2016) Ursachen und Folgen von Ausbildungsabbrüchen [Causes and consequences of drop-out from training]. *EIKV-Schriftenreihe zum Wissens- und Wertemanagement*, No. 11. European Institute for Knowledge and Value Management (EIKV). Rameldange. <http://hdl.handle.net/10419/142429>
- Seeber S (2014) Struktur und kognitive Voraussetzungen beruflicher Fachkompetenz: Am Beispiel Medizinischer und Zahnmedizinischer Fachangestellter [Structure and prerequisites of professional competence: the example of medical assistance and qualified dental employee]. *Z Erzieh* 17(1):59–80. <https://doi.org/10.1007/s11618-013-0460-7>
- Stalder BE, Schmid E (2006) Lehrvertragsauflösungen, ihre Ursachen und Konsequenzen: Ergebnisse aus dem Projekt LEVA [Termination of apprenticeship contracts, their causes and consequences: Results from the LEVA project]. Erziehungsdirektion des Kantons Bern, Bildungsplanung und Evaluation
- Statistisches Bundesamt (2023) Statistischer Bericht - Berufsbildungsstatistik 2022 (Statistical Report - Vocational Training Statistics 2022).
- Uhly A (2015) Vorzeitige Vertragslösungen und Ausbildungsverlauf in der dualen Berufsausbildung. Forschungsstand, Datenlage und Analysemöglichkeiten auf Basis der Berufsbildungsstatistik [Premature terminations of contract and training trajectories in dual VET. State of research, data and analysis possibilities based on the national training statistics]. Berlin: Bundesinstitut für Berufsbildung.
- Ulrich A, Wiench N, Frey A, Ruppert JJ (2020) Gelingenskompetenzen in der dualen Berufsausbildung: Welche Kompetenzen können als Bewältigungsressource in der dualen Ausbildung bei Jugendlichen herangezogen werden? [Competences to succeed in dual vocational training: Which competences can be used as a coping resource in dual vocational training for young people?]. In: Freiling T, Conrads R, Müller-Osten A, Porath J (eds) *Zukünftige Arbeitswelten: Facetten guter Arbeit, beruflicher Qualifizierung und sozialer Sicherung*. Springer, Wiesbaden, pp 179–203 (10.1007/978-3-658-28263-9_9)
- United Nations Educational, Scientific and Cultural Organization (UNESCO) (2015) ISCED 2011 operational manual: Guidelines for classifying national education programmes and related qualifications. UNESCO Institute for Statistics. http://uis.unesco.org/sites/default/files/documents/isced-2011-operational-manual-guidelines-for-classifying-national-education-programmes-and-related-qualifications-2015-en_1.pdf.
- Van der Meer J, Scott S, Pratt K (2018) First semester academic performance: The importance of early indicators of non-engagement. *Studies in Success* 9:1–13
- Weber P, Garcia-Murias R (2019) Wirksamkeit der Berufs- und Bildungsberatung zur Vermeidung von Ausbildungsabbrüchen [Effectiveness of career and educational counseling to avoid dropping out of training]. *Deutscher Verband für Bildungs- und Berufsberatung e. V. (dvb)*. Script 02/2019.
- Weinert FE (2001) Concept of competence: A conceptual clarification. In: Rychen DS, Salganik LH (eds) *Defining and Selecting Key Competencies*. Hogrefe and Huber, Seattle, pp 45–65
- Winther E (2010) *Kompetenzmessung in der beruflichen Bildung* [Competence measurement in vocational education and training]. Bertelsmann, Bielefeld
- Winther E (2011) Das ist doch nicht fair!–Mehrdimensionalität und Testfairness in kaufmännischen Assessments [That's not fair!–Multidimensionality and test fairness in commercial assessments]. *Zeitschrift Für Berufs- Und Wirtschaftspädagogik* 107(2):218–238. <https://doi.org/10.25162/zbw-2011-0012>
- Winther E, Achtenhagen F (2009) Measurement of vocational competencies—a contribution to an international large-scale assessment on vocational education and training. *Empirical Res Voc Educ Train* 1:85–108. <https://doi.org/10.1007/BF03546481>
- Winther E, Klotz VK (2014) Spezifika der beruflichen Kompetenzdiagnostik-Inhalte und Methodologie [Specifics of vocational competence measurement—contents and methodology]. *Z Erzieh* 17:9–32. <https://doi.org/10.1007/s11618-013-0455-4>
- Winther E, Sangmeister J, Schade AK (2013) Zusammenhänge zwischen allgemeinen und beruflichen Kompetenzen in der kaufmännischen Erstausbildung [Relations between general and vocational competences in initial commercial training]. *Zeitschrift Für Berufs- Und Wirtschaftspädagogik* 26:139–160
- Wirth J, Leutner D, Klieme E (2005) Problemlösekompetenz - Ökonomisch und zugleich differenziert erfassbar? [Problem-solving competency—can it be measured economical and differentiated?]. In: Klieme E, Leutner D, Wirth J (eds) *Problemlösekompetenz von Schülerinnen und Schülern* [Problem-solving competence in students]. VS Verlag für Sozialwissenschaften, Wiesbaden, pp 73–82
- Zumbühl M, Wolter SC (2017) Wie weiter nach der obligatorischen Schule? Bildungsentscheidungen und -verläufe der PISA-Kohorte 2012 in der Schweiz [What next after compulsory school? Educational decisions and trajectories of the PISA cohort 2012 in Switzerland]. SKBF, Aarau

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