Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Gender Segregation in the Dual Vocational Education and Training System: Curricular Profiles of Dual Training Occupations

Julia Müller

julia.mueller1@uni-bamberg.de

University of Bamberg

Research Article

Keywords: occupational selection, curricular composition, human capital, competence profiles, compositional data

Posted Date: November 24th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11515608/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Gender segregation in vocational education is usually examined as an unequal distribution of women and men across training occupations. This study asks whether that occupational sorting also produces systematic differences in the formally prescribed content of training. Using a systematic coding of German training regulations linked to individual data from NEPS Starting Cohort 4, the study distinguishes vocational skills, vocational knowledge and transferable competences and analyzes their relative composition with additive log-ratio models. Women are systematically allocated to training occupations with a greater relative emphasis on transferable competences, whereas men are allocated to occupations with a greater relative emphasis on vocational skills; vocational knowledge differs comparatively little. These associations persist when cognitive competences, social background and school-leaving qualifications are held constant. The findings show that gender segregation in dual VET has a curricular dimension: occupational sorting simultaneously structures the formally prescribed learning content attached to different training destinations.

1. Introduction

Gender segregation remains one of the most persistent features of labor markets and is already pronounced at the transition into vocational education and training. In the German dual VET system, women and men continue to be concentrated in different training occupations, with women more strongly represented in service- and administration-oriented occupations and men in technical and craft occupations (Beicht and Walden 2014; Pfahl et al. 2025). This occupational segregation is consequential because the occupations in which women and men train are associated with differences in earnings, employment prospects and opportunities for occupational mobility (Trappe 2006; Busch 2013).

At the same time, training occupations differ not only in their occupational field, but also in the content formally prescribed during training. For each training occupation recognized under the German VET system, training regulations specify the content to be taught (BIBB 2023), and curriculum-based research shows substantial differences between occupations in skill profiles, occupational specificity and competence requirements (Eggenberger et al. 2018; Fank 2025; Koneberg et al. 2026). These curricular differences are themselves relevant for later labor-market outcomes: curriculum and skill profiles are associated with labor-market opportunities and returns (Cnossen et al. 2025; Langer and Wiederhold 2023; Kiener et al. 2024), while curricular composition in German dual VET has also been linked specifically to horizontal occupational mobility (Author et al. 2026). These two strands of research have largely developed separately. Gender segregation research focuses on how women and men are distributed across occupations and on the consequences of this sorting, whereas curriculum-based research examines differences in training content and their later labor-market relevance. Bringing these perspectives together raises the question of whether gendered occupational sorting also entails systematic differences in the curricular profiles attached to the training occupations entered by women and men. If so, curricular composition may be one factor linking occupational segregation to later gender differences in labor-market outcomes.

The study distinguishes three analytically defined forms of training content: vocational skills, referring to the practical execution of occupation-specific activities; vocational knowledge, referring to subject- and occupation-related theoretical knowledge; and transferable competences, referring to broader process-oriented capacities such as planning, coordination, communication and problem-solving. It asks: To what extent are women and men sorted into dual training occupations with systematically different relative compositions of vocational skills, vocational knowledge and transferable competences?

To answer this question, the study links curricular information from official training regulations with individual longitudinal data from the National Educational Panel Study (NEPS), Cohort 4. The training regulations are coded systematically and linked to the specific training occupations observed in the NEPS. Compositional regression models then examine whether gender is associated with the relative curricular profile of the training occupation. This makes it possible to examine whether the gendered distribution across training occupations is also reflected in measurable differences in their prescribed learning content, rather than relying on occupational categories alone.

2. Previous Research

2.1 Gender Segregation in the German Dual VET System

Gender-specific occupational segregation refers to the unequal distribution of women and men across occupational fields and areas of activity and is commonly described as horizontal gender segregation (Charles and Grusky 2004; England 2010). Despite substantial changes in educational attainment and labor-market participation, gender-specific patterns of educational and occupational allocation remain pronounced (Charles and Bradley 2009; Busch 2013; Hausmann and Kleinert 2014). These patterns are also evident in the German dual VET system. Young women remain disproportionately concentrated in commercial, administrative, medical-assisting and personal-service training occupations, whereas young men are much more strongly represented in technical, industrial and craft occupations (Beicht and Walden 2014; Pfahl et al. 2025). Recent training statistics show that this horizontal segregation remains persistent (BIBB 2023; BMBF 2024; Pfahl et al. 2025). Similar patterns have also been documented in Switzerland, particularly in STEM-related vocational training choices (Gutfleisch and Nennstiel 2025).

Research on transitions into vocational training has examined both individual occupational orientations and employer-side selection as factors associated with gendered allocation patterns. Gendered socialization and occupational aspirations shape which occupations young people perceive as suitable or attainable (Bussey and Bandura 1999; Buchmann and Kriesi 2012). At the same time, access to firm-based training positions is mediated by employers. Evidence on recruitment and transition chances indicates that employer-side selection and gender discrimination can reinforce gender-typical allocation patterns (Beicht and Walden 2014; Kübler et al. 2018). Accordingly, previous research has considered both individual and employer-side processes in explaining gendered patterns of entry into VET.

A smaller body of research has examined whether female- and male-dominated occupations also differ in qualification-related characteristics. Tam (1997) discusses specialized human capital as one explanation for gender inequalities, while Grönlund and Magnusson (2013) examine differences in specific human capital between female- and male-dominated occupations. In vocational education, Grønning et al. (2020) analyze the relationship between skill specificity and the gender pay gap. These studies point to qualification-related differences as a relevant dimension of gendered occupational segregation, but they do not examine the internal curricular composition of training qualifications.

2.2 Competence Profiles of Training Occupations and Training Regulations as a Data Source

A second strand of research examines differences in occupational skill and competence requirements. Much labor-market research captures such differences indirectly through ex-post information on tasks and skill requirements. Task-based research captures occupational heterogeneity through the activities performed at work. Autor et al. (2003) distinguish routine and non-routine cognitive and manual tasks and examine how computerization changes their relative importance. Using German data, Spitz-Oener (2006) differentiates analytical and interactive non-routine tasks as well as cognitive routine, manual routine and manual non-routine tasks and traces changes in these task requirements within occupations. Arntz et al. (2016) use individual-level task information to estimate the susceptibility of jobs to automation, allowing for task differences among workers within the same occupation. These approaches provide detailed information on the tasks and requirements of jobs, but they do not directly observe the content that vocational education is institutionally prescribed to provide.

Training curricula offer a direct alternative because they make it possible to study the formally prescribed content of vocational qualifications rather than inferring this content from later job tasks. Several studies demonstrate the potential of this curriculum-based approach. Eggenberger et al. (2018), for example, derive a measure of occupational specificity from Swiss VET curricula. In the German dual VET system, training regulations provide a particularly suitable source for this purpose. They specify in binding terms which knowledge, skills and competences are to be taught in each recognized training occupation and how this content is structured over the training period (BIBB 2023). Hensge et al. (2009) develop a competence model for training regulations and apply it to four dual training occupations, distinguishing technical, methodological, social and personal dimensions of occupational competence. Protsch (2013) analyzes the training time allocated to different content areas; Fank (2025) derives a measure of occupational specificity from German training curricula; and Koneberg et al. (2026) document substantial differences in competence profiles across German training programs. These studies show that training regulations provide a systematic basis for comparing heterogeneity across vocational qualifications.

Curricular and skill-profile research also shows why this heterogeneity is substantively relevant. Cnossen et al. (2025) relate vocational curricula to returns to different skills, while Langer and Wiederhold (2023) examine the labor-market value of skills specified in standardized apprenticeship plans. In German dual

VET, Author et al. (2026) link curricular composition to later horizontal occupational mobility. Related work further shows how vocational skill profiles interact with technological change. Kiener et al. (2024) examine how occupational specialization and social skills shape wage returns as information technology advances, while Salomons et al. (2025) show that technological innovations lead to updates in German training curricula toward more digital and social skills and less routine-intensive content, with such updates also associated with better subsequent labor-market outcomes.

Training regulations describe the qualification formally attached to an occupation; they do not measure the tasks performed by a particular worker or the competences actually acquired by an individual trainee. Existing curriculum-based studies operationalize qualification content in different ways and do not provide a ready-made classification of the internal composition of German training regulations into the three forms examined here. The distinction between vocational skills, vocational knowledge and transferable competences is therefore used as an analytical coding framework for the present content analysis.

Taken together, the literature on gender segregation and the literature on vocational skill profiles point to a gap at their intersection. Research on gender segregation shows that women and men are distributed across different training occupations, while curriculum-based research shows that these occupations differ systematically in their qualification content and that such differences can matter for later labor-market outcomes. What remains unclear is whether gendered sorting into VET is also reflected in systematically different curricular compositions. The present study addresses this question by linking individual training transitions with occupation-specific curricular information and by examining curricular content as a compositional qualification structure.

3. Theoretical Framework

3.1 Dimensions of Curricular Training Content

The curricular categories used in this study are grounded in the institutional and competence-oriented structure of German VET. The German Vocational Training Act (BBiG) defines vocational training as the acquisition of the vocational skills, knowledge and abilities required to perform qualified occupational activities in a changing world of work (BBiG § 1(3)). For each recognized training occupation, training regulations and associated training framework plans specify the content and temporal structure of in-company training, while framework curricula define the basis for school-based instruction (BIBB 2023). These documents therefore provide the institutional basis for identifying the forms of content formally prescribed within vocational qualifications.

Competence-oriented approaches in vocational education emphasize that occupational action requires more than the acquisition of isolated factual knowledge or narrowly defined practical procedures. Instead, vocational competence involves the ability to understand, perform and reflect upon occupational tasks within broader work processes (Euler 2018). This perspective emphasizes that

vocational learning involves the integration of knowledge, practical abilities and the capacity to act appropriately in occupational situations. Building on this competence-oriented perspective, the present study distinguishes three forms of prescribed training content: vocational skills, vocational knowledge and transferable competences. This distinction is informed by concepts of vocational and transversal competence (Euler 2018; Scharnhorst and Kaiser 2018), but it does not represent an established typology of human capital dimensions. Rather, the categories provide an analytical framework for classifying training content according to their primary function and typical range of application.

Vocational skills refer to the practical execution of occupation-specific activities. They include, for example, handling materials, operating tools and machines, and performing specific occupational procedures. Such content is closely connected to particular work processes, technologies and practical applications.

Vocational knowledge refers to theory-based and occupation-related knowledge that provides the cognitive foundation for understanding occupational activities and contexts. It includes knowledge of technical systems, materials, operational processes, professional standards and relevant rules. Compared with vocational skills, it is less directly tied to the execution of individual procedures but remains closely related to occupational contexts.

Transferable competences refer to broader capacities that support action across different tasks and work situations. Following competence-oriented approaches, these include planning, coordination, communication, problem-solving and the ability to understand and shape broader work processes (Euler 2018; Scharnhorst and Kaiser 2018). Their defining characteristic is that their relevance extends beyond a specific material, tool or narrowly defined task and can therefore apply across different occupational contexts.

The three categories are analytical distinctions used to classify prescribed training content. Although occupational activities typically combine knowledge, skills and broader competences, each coded element is assigned to one category for the content analysis. Training occupations can therefore be compared according to their relative curricular composition.

3.2 Occupational Sorting as Allocation to Vocational Human Capital

Occupational allocation in dual VET has consequences beyond the distribution of individuals across fields of work. Training occupations are not only categories of labor-market activity but also standardized qualification programs that prescribe different combinations of vocational knowledge, skills and competences. Entering a particular occupation therefore also means entering a particular qualification environment with a specific curricular profile.

This consequence of occupational allocation can be understood as curricular sorting. Curricular sorting does not refer to an additional selection process at the level of individual training content. Applicants

and employers do not directly select single curricular components; rather, the curricular profile follows from the training occupation into which an individual is allocated. Occupational destinations therefore differ in the combinations of vocational resources formally prescribed in their curricula.

Human capital theory provides a framework for understanding why such differences in qualification profiles may be substantively relevant. Becker (1962) conceptualizes human capital as productive knowledge and skills and distinguishes between general and specific human capital. Whereas general human capital can be transferred across contexts, the value of specific human capital depends on the context in which it is applied. Subsequent research extends this perspective by emphasizing occupational specificity as an additional dimension of human capital, referring to the extent to which vocational resources are tied to particular occupational contexts and transferable across occupations (Kambourov and Manovskii 2009).

From this perspective, training occupations can be understood as institutionally defined configurations of vocational human capital. Vocational skills and vocational knowledge are often more closely related to occupation-specific resources because they are connected to particular occupational practices and knowledge domains. Transferable competences, in contrast, share characteristics with more general forms of human capital because their relevance extends beyond narrowly defined occupational contexts.

3.3 Gendered Occupational Sorting

Having established why training occupations can be understood as different configurations of vocational resources, the following section turns to the processes through which women and men become distributed across different occupational destinations. Gender segregation in vocational training refers to the unequal distribution of women and men across training occupations. Rather than reflecting a single mechanism, this distribution is shaped by the interplay of culturally shared beliefs about gender, individual occupational orientations and employer-side selection.

Gender essentialism provides one explanation for why occupations become associated with women or men. It refers to culturally shared beliefs that women and men possess different abilities, interests and dispositions and are therefore suited to different types of work (Charles and Grusky 2004). Women are more strongly associated with relational, caring, communicative and organizational activities, whereas men are more frequently associated with technical, mechanical, physical and production-oriented work (Charles and Bradley 2009; Busch 2013). These culturally shared associations shape occupational images and influence which occupations are perceived as appropriate, attractive or attainable for women and men.

Such perceptions can develop well before an actual training decision is made. Social cognitive approaches emphasize that occupational orientations develop through observation, social interaction, feedback and perceptions of one’s own abilities (Bussey and Bandura 1999). Correll (2001) shows how gendered cultural beliefs can affect self-assessments of competence even when actual ability is held constant, thereby influencing subsequent career-related choices. Eccles (1994) similarly emphasizes the

role of expectations, perceived competence and subjective task values in gendered educational and occupational decisions. Gendered perceptions of competence and occupational fit can therefore narrow the range of occupations considered suitable or attainable and contribute to gendered self-selection (Buchmann and Kriesi 2012).

Beyond these culturally shaped orientations, occupational decisions may also reflect expectations about future employment trajectories. From a human-capital perspective, individuals may take into account how occupational choices affect the future use and returns of acquired skills. Polachek (1981), for example, argues that anticipated employment interruptions can influence occupational choice if occupations differ in the depreciation and transferability of human capital. In the context of vocational training, such expectations may contribute to gender differences in occupational destinations if women and men anticipate different employment trajectories or evaluate the long-term usefulness of occupational qualifications differently.

Occupational allocation in the German dual VET system, however, is not determined by applicants' orientations alone. Entry into firm-based training also depends on employers' recruitment and selection decisions. Access to a training occupation requires obtaining a training position, giving firms an important role in determining which occupational destinations are realized. Employers may evaluate applicants through gendered assumptions about technical ability, social competence, physical suitability or anticipated commitment. Experimental evidence from Germany shows that gender discrimination in hiring varies across occupations (Kübler et al. 2018). More recent evidence from the German apprenticeship market also indicates that recruiter characteristics and recruitment decisions can contribute to gender segregation in apprenticeship occupations (Minssen et al. 2025). Employer-side selection may therefore reinforce gender-typical patterns of occupational allocation, even when applicants themselves consider a broader range of occupations.

Gendered occupational sorting in dual VET therefore reflects both individual orientations and employer-side selection, each of which is embedded in broader cultural beliefs about gender. These processes may reinforce one another over the course of the transition into training. The analysis does not decompose their relative contributions, but focuses on the resulting gendered distribution across training occupations.

3.4 Hypotheses

Training occupations differ in the relative composition of vocational skills, vocational knowledge and transferable competences prescribed in their curricula. Because occupational allocation therefore also entails allocation to different combinations of these vocational resources, gender segregation may have curricular consequences in addition to producing different occupational destinations. If women and men are systematically sorted into different types of training occupations, they may also be sorted into occupations with systematically different formally prescribed curricular profiles.

How these profiles are expected to differ follows from combining this curricular perspective with the mechanisms of gendered occupational sorting discussed above. A human-capital perspective provides an additional point of reference because vocational resources differ in the extent to which their application is tied to particular occupational contexts (Becker 1962; Kambourov and Manovskii 2009). Transferable competences can be applied across a broader range of tasks and situations, whereas vocational skills are more closely connected to specific occupational practices. Although the categories used here are not direct equivalents of general and specific human capital, this distinction helps characterize the different types of resources attached to occupational destinations.

These differences in vocational resources become relevant for gender segregation because women and men are not sorted randomly across occupations. Gender essentialist beliefs associate women more strongly with relational, communicative, caring and organizational activities, whereas men are more strongly associated with technical, mechanical, physical and production-oriented work (Charles and Grusky 2004; Charles and Bradley 2009; Busch 2013). Such associations can shape which occupations appear suitable or attainable by influencing perceptions of competence and occupational fit (Bussey and Bandura 1999; Correll 2001; Eccles 1994). At the same time, employer-side selection may reinforce these patterns when similar gendered expectations enter recruitment decisions (Kübler et al. 2018; Minssen et al. 2025).

When these gendered patterns of occupational allocation are related to the curricular distinctions outlined above, a first expectation concerns transferable competences. Relational, communicative and organizational activities rely strongly on capacities such as communication, coordination, planning and interaction across different tasks and situations. Because these capacities correspond closely to transferable competences, occupations in which such activities are more prominent should also place greater relative emphasis on this form of training content. If women are more often sorted into such occupations, they should therefore enter training programs in which transferable competences account for a greater relative share of the curriculum.

Vocational knowledge serves as the common reference component because it captures the occupation-related cognitive core of training, against which the expected gendered shifts toward broader transferable competences or more task-specific vocational skills can be expressed. Both hypotheses are therefore formulated relative to vocational knowledge:

H1 Transferable Competences

Compared with men, women are sorted into dual training occupations with a higher ratio of transferable competences to vocational knowledge.

The same link between gendered occupational sorting and curricular composition leads to a corresponding expectation for vocational skills. Technical, mechanical, physical and production-oriented work is more closely connected to the practical execution of occupation-specific activities using particular tools, machines, materials and procedures. Since this type of content corresponds to

vocational skills, occupations characterized by such activities should place greater relative emphasis on vocational skills in their curricula. If men are more often sorted into these occupations, vocational skills should therefore occupy a greater relative position in the curricular profiles of the occupations they enter. A stronger relative emphasis on vocational skills among the occupations entered by men consequently implies a lower ratio of vocational skills to vocational knowledge among women:

H2 Vocational Skills

Compared with men, women are sorted into dual training occupations with a lower ratio of vocational skills to vocational knowledge.

4. Data

The empirical analysis combines two sources of information that are usually observed separately: the formally prescribed content of dual vocational training and individual transitions into training. Curricular information from official training regulations is linked to longitudinal data from the National Educational Panel Study (NEPS). This linkage makes it possible to examine not only which training occupation an individual enters, but also the specific composition of training content institutionally attached to that occupation.

The curricular data are derived from the nationally regulated training regulations of the German dual VET system. These regulations specify the skills, knowledge and competences to be taught within each recognized training occupation and provide temporal guidelines for the different areas of training. The resulting database therefore captures the formally prescribed content of vocational qualifications directly, rather than inferring qualification content from occupational titles or tasks observed later in employment. It was developed to make curricular differences across dual training occupations systematically and quantitatively comparable.

The training regulations were coded using a systematic content analysis based on a common set of coding rules. Prescribed learning content was assigned to vocational skills, vocational knowledge or transferable competences and weighted by the corresponding training time. Ambiguous cases were discussed and resolved consensually, and the resulting time values were aggregated in weeks to obtain a curricular profile for each training occupation. These indicators describe institutionally prescribed curricular profiles rather than competences measured at the individual level.

The occupation-specific curricular information is linked to individual longitudinal data from Starting Cohort 4 of the National Educational Panel Study (NEPS; Blossfeld et al. 2011; NEPS Network 2025). The cohort follows educational trajectories from school into vocational training and subsequent employment. The base analytical sample comprises 2,642 individuals who entered dual vocational training during the observation period. Individuals who attended special education schools and cases without valid information on the training occupation are excluded. Because the multivariate models

additionally require complete information on the covariates, the regression sample reported in Tables 1 and 2 comprises 2,373 observations.

The linkage is based on the five-digit German Classification of Occupations (KldB 2010; Federal Employment Agency 2011). Because a KldB five-digit code does not always uniquely identify a particular training regulation, information on the timing of training and the official duration of the training program is additionally used to identify the applicable curricular profile.

5. Variables and Method

The dependent variables describe the relative curricular composition of dual training occupations. For each applicable training regulation, the prescribed learning time allocated to vocational skills, vocational knowledge and transferable competences is measured in weeks over the regular duration of training. Because, within each training regulation, these learning times add up to the total prescribed training duration, they constitute compositional data: the components cannot vary independently, since a larger share of one component necessarily reduces the relative share available to at least one other component. To account for this dependence, the content shares are transformed using an additive log-ratio transformation (Aitchison 1986; Pawlowsky-Glahn and Buccianti 2011).

The additive log-ratio transformation expresses each component relative to a reference component. Vocational knowledge is used as the reference because it captures the occupation-related cognitive core of the curriculum and provides a substantively interpretable benchmark for comparing more task-specific vocational skills with broader transferable competences. Since the logarithm is undefined for zero values, components with a value of zero were replaced by 0.0001 prior to the transformation. The analysis therefore models the relative emphasis on transferable competences and vocational skills compared with vocational knowledge:

$$ALR_1 = \ln\left(\frac{Transferable\ competences_i}{Vocational\ knowledge_i}\right) \text{ and } ALR_2 = \ln\left(\frac{Vocational\ skills_i}{Vocational\ knowledge_i}\right)$$

where transferable competences$_i$, vocational knowledge$_i$ and vocational skills$_i$ represent the respective learning times in weeks for training occupation$_i$.

The transformed variables capture the relative prominence of transferable competences and vocational skills compared with vocational knowledge within a training occupation. Positive values indicate that the respective content category accounts for more prescribed learning time than vocational knowledge, whereas negative values indicate that it accounts for less. A value of zero indicates equal amounts of prescribed learning time in the respective category and vocational knowledge.

Linear regression models are then estimated to examine whether gender is associated with the curricular composition of the training occupations entered. The central independent variable is the gender of the trainees, operationalized as a dichotomous variable with women coded as 1 and men as 0.

Accordingly, the gender coefficient indicates whether women are allocated to training occupations with systematically different relative curricular profiles than men.

Because several individuals can enter the same training occupation and therefore share an identical curriculum-based outcome, their observations cannot be treated as fully independent for statistical inference. The analytical sample contains 119 distinct five-digit KldB-2010 occupational codes. Cluster-robust standard errors are therefore calculated at the five-digit KldB-2010 code level, allowing regression errors to be correlated within codes (Cameron and Miller 2015).

To account for individual characteristics associated with educational and occupational placement, the models introduce three sets of controls. Mathematical and reading competences capture cognitive resources, parental occupational status, measured by the International Socio-Economic Index of Occupational Status (ISEI), captures one dimension of social background, and the highest general school-leaving qualification captures formally certified educational attainment. Previous research on occupational choice and transitions into vocational training shows that educational resources and social background are associated with access to and selection into training occupations (Beicht and Walden 2014; Buchmann and Kriesi 2012). Model 1 includes gender only, Model 2 adds cognitive competences, Model 3 adds parental ISEI, and Model 4 additionally includes school-leaving qualification.

The analysis first compares the curricular profiles associated with women's and men's training occupations descriptively and then examines whether these differences persist once the observed individual characteristics are taken into account. The stepwise specification is not intended as a causal decomposition of the selection process; rather, it shows how the estimated gender association changes when cognitive competences, social background and educational attainment are held constant. For this reason, the analysis does not separately identify the contributions of self-selection and employer-side selection.

Finally, adjusted predictions are calculated from the fully specified models (Model 4) to make the log-ratio results easier to interpret substantively. Covariates are retained at their observed values and predictions are averaged over the estimation sample. The two predicted log-ratios are then combined and back-transformed to the compositional scale, yielding predicted shares of all three content categories that sum to 100%. In this way, the relative log-ratio differences are translated into directly comparable curricular shares, while 95% confidence intervals are calculated using the delta method.

6. Results

6.1 Descriptive Results

The analytical sample reflects the pronounced horizontal gender segregation documented for the German dual VET system, as women and men are concentrated in different training occupations. The relevant question for the present study is whether this occupational distribution is also accompanied by systematic differences in the curricular content attached to these occupations. The descriptive analysis

therefore shifts attention from occupational destinations themselves to the training content institutionally associated with them.

Figure 1 shows clear differences in two of the three curricular components. The training occupations entered by women contain, on average, 61.9 weeks of transferable competences, compared with 48.6 weeks among men. By contrast, vocational skills account for only 15.1 weeks in the occupations entered by women, whereas the corresponding value among men is 39.4 weeks. Vocational knowledge, however, is much more similar, amounting to 81.3 weeks among women and 80.1 weeks among men. Thus, the descriptive gender difference is concentrated primarily in transferable competences and vocational skills rather than vocational knowledge.

These descriptive differences are consistent with different curricular compositions, which are examined formally in the compositional models below. Women are more strongly represented in occupations whose curricula contain a larger transferable-competence component, whereas men are more strongly represented in occupations with a substantially larger vocational-skills component. The descriptive pattern is therefore consistent with the expectation that gendered occupational sorting is also accompanied by sorting into different configurations of vocational resources. The multivariate analysis examines whether this pattern remains once observed differences in cognitive competences, social background and educational attainment are taken into account.

Legend: Average prescribed training weeks in transferable competences, vocational knowledge, and vocational skills for the occupations entered by women and men.

6.2 Multivariate Results

Tables 1 and 2 report the multivariate associations between gender and the two additive log-ratios. The stepwise specifications show how the gender coefficients change as cognitive competences, parental occupational status and school-leaving qualification are successively introduced. Because women are coded as 1 and men as 0, positive coefficients indicate a higher relative value among women, whereas negative coefficients indicate a lower relative value. At the same time, the coefficients refer to log-ratios and should therefore be interpreted as differences in relative curricular composition rather than directly as percentage-point differences.

Table 1
Regression of transferable competences relative to vocational knowledge (ALR)

	(1)	(2)	(3)	(4)
	Model 1	**Model 2**	**Model 3**	**Model 4**
Men (reference)	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)
Women	0.295**	0.290**	0.296**	0.273**
	(0.128)	(0.129)	(0.130)	(0.124)
Mathematical competence		0.000	-0.006	-0.025
		(0.033)	(0.030)	(0.026)
Reading competence		0.033	0.029	0.009
		(0.023)	(0.023)	(0.023)
Social origin (parental ISEI)			0.003*	0.002
			(0.002)	(0.001)
No school-leaving certificate (reference)				0.000
				(.)
Lower secondary school-leaving certificate				-0.426***
				(0.140)
Intermediate school-leaving certificate				-0.275*
				(0.158)
Higher education entrance qualification				-0.191
				(0.217)
Constant	-0.651***	-0.645***	-0.788***	-0.467**
	(0.123)	(0.121)	(0.123)	(0.222)
Observations	2373	2373	2373	2373
R-squared	0.036	0.038	0.043	0.053

Standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01

For the ratio of transferable competences to vocational knowledge, all four specifications show a positive and statistically significant coefficient for women. The coefficient is 0.295 in Model 1 and changes only slightly as the controls are introduced, to 0.290 in Model 2, 0.296 in Model 3 and 0.273 in

Model 4 (all $p < 0.05$). The positive sign indicates that the occupations entered by women have a higher ratio of transferable competences to vocational knowledge than those entered by men.

This finding supports Hypothesis H1. Women are sorted into training occupations with a higher ratio of transferable competences to vocational knowledge. The association persists after accounting for cognitive competences, parental occupational status and educational attainment, although the models do not establish a causal gender effect.

Table 2
Regression of vocational skills relative to vocational knowledge (ALR)

	(1)	(2)	(3)	(4)
	Model 1	**Model 2**	**Model 3**	**Model 4**
Men (reference)	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)
Women	-2.663***	-2.713***	-2.748***	-2.359***
	(0.596)	(0.548)	(0.542)	(0.538)
Mathematical competence		-0.233	-0.195	0.089
		(0.178)	(0.170)	(0.143)
Reading competence		-0.350**	-0.326**	-0.056
		(0.161)	(0.157)	(0.118)
Social origin (parental ISEI)			-0.017**	-0.004
			(0.007)	(0.006)
No school-leaving certificate (reference)				0.000
				(.)
Lower secondary school-leaving certificate				1.794**
				(0.883)
Intermediate school-leaving certificate				0.728
				(0.966)
Higher education entrance qualification				-1.478
				(1.149)
Constant	-2.468***	-2.512***	-1.692***	-2.703**
	(0.600)	(0.582)	(0.635)	(1.194)
Observations	2373	2373	2373	2373
R-squared	0.118	0.140	0.147	0.224

Standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01

A pronounced negative association is evident for the ratio of vocational skills to vocational knowledge. Women have significantly lower values than men in every specification: the coefficient is -2.663 in Model 1, -2.713 in Model 2, -2.748 in Model 3 and − 2.359 in the fully specified Model 4 (all p < 0.01). The

negative coefficients indicate that vocational skills occupy a substantially smaller position relative to vocational knowledge in the curricular profiles of the occupations entered by women. Although the coefficient becomes somewhat smaller in absolute terms in the fully specified model, the association remains pronounced after the observed individual characteristics are included.

This result supports Hypothesis H2. Compared with men, women are sorted into training occupations with a lower ratio of vocational skills to vocational knowledge. Conversely, men are more strongly represented in training occupations with a larger relative vocational-skills component. The two sets of models therefore point in complementary directions: women are associated with a greater relative emphasis on transferable competences, whereas men are associated with a greater relative emphasis on vocational skills.

Whereas Fig. 1 provides an unadjusted descriptive comparison, Fig. 2 shows adjusted predicted curricular shares based on the fully specified models. Because the log-ratio coefficients are difficult to translate directly into curricular magnitudes, Fig. 2 expresses the estimates from Model 4 as predicted shares of the three content categories. By combining and back-transforming the two predicted log-ratios, the adjusted predictions retain the compositional constraint that the three components sum to 100% while allowing their relative magnitudes to be compared directly.

Legend: Approximate shares from Model 4 as reported in Section 6.2.

The adjusted predictions confirm the difference in curricular composition. For men, approximately 32% of prescribed training content is predicted to consist of transferable competences, around 60% of vocational knowledge and about 8% of vocational skills. For women, the corresponding predicted shares are approximately 41%, 58% and 1%, respectively. The predicted profiles therefore differ primarily in the balance between transferable competences and vocational skills, while vocational knowledge remains comparatively stable. This corresponds to a difference of about nine percentage points in transferable competences and seven percentage points in vocational skills. The back-transformed estimates thus show that the gender difference concerns the composition of prescribed training content rather than a uniform shift across all three components.

7. Discussion

This study examined whether the well-established gender segregation of the German dual VET system is accompanied by systematic differences in the formally prescribed content of training. By linking training regulations with individual NEPS data, the analysis goes beyond occupational titles and compares the curricular profiles attached to the training occupations entered by women and men.

The results show such a curricular pattern. Women are more strongly represented in training occupations whose curricula place greater relative emphasis on transferable competences, whereas men are more strongly represented in occupations in which vocational skills have greater relative weight compared with vocational knowledge. These differences remain when cognitive competences, social

background and educational attainment are held constant. Gender segregation in VET therefore concerns not only which occupational field an individual enters, but also which combination of practical skills, occupation-related knowledge and broader transferable competences is formally attached to that destination.

This extends previous research, which has primarily described segregation as an unequal distribution across occupational categories and examined how women and men come to occupy different occupational fields (Charles and Grusky 2004; Busch 2013; Hausmann and Kleinert 2014; Beicht and Walden 2014). Because training occupations are also standardized qualification programs, however, different occupational destinations are associated with different formally prescribed combinations of vocational resources. The curricular perspective therefore adds an institutional dimension to occupational segregation by showing that gendered allocation across occupations is simultaneously an allocation across different qualification structures.

Furthermore, vocational qualifications consist of bundles of resources whose use and portability can vary across occupational contexts. Human capital theory conceptualizes education and training as investments in productive knowledge and skills (Becker 1962), while research on occupational specificity emphasizes that these resources differ in how broadly they can be applied (Kambourov and Manovskii 2009; Eggenberger et al. 2018). Against this background, the results show that women and men are already allocated to differently composed vocational resources at the point of training. The analysis does not assess whether one curricular profile yields higher returns than another, but it identifies a gendered difference in the composition of the qualifications attached to occupational destinations.

The observed pattern is also consistent with the mechanisms of occupational sorting discussed in the theoretical framework. Gendered occupational orientations and anticipated employment trajectories can shape self-selection (Bussey and Bandura 1999; Buchmann and Kriesi 2012; Polachek 1981), while firms mediate access to training positions and may reinforce gender-typical allocation patterns (Beicht and Walden 2014; Kübler et al. 2018). Because curricula are attached to occupations, either mechanism can produce differences in curricular allocation even though applicants do not explicitly choose between transferable competences, vocational knowledge and vocational skills. A next step is therefore to examine more directly how applicant-side orientations and employer-side selection contribute to the observed curricular sorting and whether their relative importance differs across types of training occupations.

These differences may also matter beyond the point of entry into training. Existing research shows that the specificity and composition of vocational qualifications are associated with outcomes such as occupational mobility and returns to skills (Eggenberger et al. 2018; Damelang et al. 2015; Menze 2017; Vicari 2018; Cnossen et al. 2025). Complementary longitudinal evidence from German dual VET further indicates that curricular composition is associated with horizontal occupational mobility (Author et al. 2026). Whether the gender differences identified here translate into differences in mobility, employment stability, earnings or adaptation to structural change, however, remains an open empirical question. The

present findings therefore concern the distribution of formally prescribed training content at the point of vocational allocation rather than the causal effects of that content on subsequent careers.

Two limitations follow directly from this design. First, entry into dual training reflects both individual occupational orientations and selection on the training market. Although the gender coefficients remain when cognitive competences, social background and educational attainment are held constant, the observational design does not allow the relative contribution of these mechanisms to be identified. Future analyses should therefore combine information on occupational preferences, applications and realized training placements in order to trace more closely where in the allocation process curricular differences emerge. Second, the curricular indicators describe formally prescribed training content rather than training as implemented in every firm or competences actually acquired by individual trainees. Actual training practices may therefore vary. At the same time, the national standardization of training regulations is an advantage for the present research question because it provides a common institutional basis for comparing the intended curricular profiles of recognized training occupations (BIBB 2023).

8. Conclusions

This study adds a curricular perspective to research on gender segregation in the German dual VET system. It shows that gender segregation extends beyond the distribution of women and men across training occupations to the composition of the vocational qualifications associated with these occupations. By opening up occupational categories and examining their underlying curricular profiles, the study demonstrates that gendered occupational sorting also entails systematic differences in the vocational resources formally prescribed during training.

A particular contribution of this study lies in its empirical approach. By linking individual training trajectories from the National Educational Panel Study to a newly developed dataset based on the systematic coding of German training regulations, the analysis makes it possible to look beyond occupational categories and examine the curricular composition of vocational qualifications. This reveals a dimension of gender segregation that remains largely invisible when occupational destinations are considered alone.

These findings also provide a starting point for further research. Understanding how women and men are sorted into occupations with different curricular profiles may help clarify the role of individual occupational orientations and employer-side selection in producing gender inequalities. Moreover, differences in the composition of vocational qualifications may have consequences for later employment opportunities and occupational mobility. Examining whether and how these differences contribute to subsequent labor market inequalities is therefore an important direction for future research.

Abbreviations

ALR
Additive log–ratio
BBiG
German Vocational Training Act (Berufsbildungsgesetz)
BIBB
Federal Institute for Vocational Education and Training (Bundesinstitut für Berufsbildung)
BMBF
Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung)
ISEI
International Socio–Economic Index of Occupational Status
KldB 2010
German Classification of Occupations 2010 (Klassifikation der Berufe 2010)
NEPS
National Educational Panel Study
STEM
Science, Technology, Engineering and Mathematics
VET
Vocational education and training

Declarations

Author Contribution

only one author

Data Availability

The curricular data used in this study were developed by systematically coding German vocational training regulations. The dataset and accompanying methodological documentation are publicly available on the project website of the University of Bamberg: https://www.uni-bamberg.de/arbeitswiss/forschung/drittmittelprojekte/. The individual-level NEPS data are available through the Research Data Centre of the Leibniz Institute for Educational Trajectories (LIfBi), subject to the applicable access conditions.

References

1. Aitchison J (1986) The statistical analysis of compositional data. Chapman and Hall, London
2. Arntz M, Gregory T, Zierahn U (2016) The risk of automation for jobs in OECD countries: a comparative analysis. OECD Social, Employment and Migration Working Papers, No. 189. OECD Publishing, Paris

3. Author et al (2026) [Reference omitted for anonymized review]. Manuscript in
4. Autor DH, Levy F, Murnane RJ (2003) The skill content of recent technological change: an empirical exploration. Q J Econ 118:1279–1333. https://doi.org/10.1162/003355303322552801
5. Becker GS (1962) Investment in human capital: a theoretical analysis. J Polit Econ 70:9–49. https://doi.org/10.1086/258724
6. Beicht U, Walden G (2014) Berufswahl junger Frauen und Männer: Übergangschancen in betriebliche Ausbildung und erreichtes Berufsprestige. BIBB Report 4/2014. Bundesinstitut für Berufsbildung, Bonn
7. Blossfeld HP, Roßbach HG, von Maurice J (eds) (2011) Education as a lifelong process: the German National Educational Panel Study (NEPS). Zeitschrift für Erziehungswissenschaft, Special Issue 14. VS Verlag für Sozialwissenschaften, Wiesbaden
8. Buchmann M, Kriesi I (2012) Geschlechtstypische Berufswahl: Begabungszuschreibungen, Aspirationen und Institutionen. In: Becker R, Solga H (eds) Soziologische Bildungsforschung. Springer VS, Wiesbaden, pp 256–280. https://doi.org/10.1007/978-3-658-00120-9_11
9. Bundesinstitut für Berufsbildung (BIBB) (ed) (2023) Datenreport zum Berufsbildungsbericht 2023: Informationen und Analysen zur Entwicklung der beruflichen Bildung. Bundesinstitut für Berufsbildung, Bonn
10. Bundesministerium für Bildung und Forschung (BMBF) (ed) (2024) Berufsbildungsbericht 2024. Bundesministerium für Bildung und Forschung, Bonn
11. Busch A (2013) Der Einfluss der beruflichen Geschlechtersegregation auf den „Gender Pay Gap: Zur Bedeutung geschlechtlich konnotierter Arbeitsinhalte. Kölner Z Soziol Sozialpsychol 65:301–338
12. Bussey K, Bandura A (1999) Social cognitive theory of gender development and differentiation. Psychol Rev 106:676–713. https://doi.org/10.1037/0033-295X.106.4.676
13. Cameron AC, Miller DL (2015) A practitioner's guide to cluster-robust inference. J Hum Resour 50:317–372. https://doi.org/10.3368/jhr.50.2.317
14. Charles M, Bradley K (2009) Indulging our gendered selves? Sex segregation by field of study in 44 countries. Am J Sociol 114:924–976. https://doi.org/10.1086/595942
15. Charles M, Grusky DB (2004) Occupational ghettos: the worldwide segregation of women and men. Stanford University Press, Stanford, CA
16. Cnossen F, Piracha M, Tchuente G (2025) Learning the right skill: vocational curricula and returns to skills. J Labor Econ 43:665–694. https://doi.org/10.1086/730123
17. Correll SJ (2001) Gender and the career choice process: the role of biased self-assessments. Am J Sociol 106:1691–1730. https://doi.org/10.1086/321299
18. Damelang A, Schulz F, Vicari B (2015) Institutionelle Eigenschaften von Berufen und ihr Einfluss auf berufliche Mobilität in Deutschland. Schmollers Jahrb 135:307–333. https://doi.org/10.3790/schm.135.3.307

19. Eccles JS (1994) Understanding women's educational and occupational choices: applying the Eccles model of achievement-related choices. Psychol Women Q 18:585–609. https://doi.org/10.1111/j.1471-6402.1994.tb01049.x
20. Eggenberger C, Rinawi M, Backes-Gellner U (2018) Occupational specificity: a new measurement based on training curricula and its effect on labor market outcomes. Labour Econ 51:97–107. https://doi.org/10.1016/j.labeco.2017.11.010
21. England P (2010) The gender revolution: uneven and stalled. Gend Soc 24:149–166
22. Euler D (2018) Kompetenzorientierung in der beruflichen Bildung. In: Arnold R, Lipsmeier A, Rohs M (eds) Handbuch Berufsbildung. Springer VS, Wiesbaden, pp 1–13. https://doi.org/10.1007/978-3-658-19372-0_18-1
23. Fank J (2025) Die Berufsspezifität von Ausbildungsberufen in Deutschland: eine Analyse auf Basis von Ausbildungscurricula. Version 1.0. Bundesinstitut für Berufsbildung, Bonn. https://res.bibb.de/vet-repository_783824
24. Federal Employment Agency (2011) Klassifikation der Berufe 2010 – Band 1: Systematischer und alphabetischer Teil mit Erläuterungen. Federal Employment Agency, Nuremberg
25. Grönlund A, Magnusson C (2013) Devaluation, crowding or skill specificity? Exploring the mechanisms behind the lower wages in female professions. Soc Sci Res 42:1006–1017. https://doi.org/10.1016/j.ssresearch.2013.03.001
26. Grønning M, Kriesi I, Sacchi S (2020) Skill specificity of upper-secondary training occupations and the gender pay gap. Kölner Z Soziol Sozialpsychol 72(Suppl 1):291–315
27. Gutfleisch T, Nennstiel R (2025) Bridging the gap: gender-specific preferences in STEM occupations in vocational education and training. Empir Res Vocat Educ Train 17:12. https://doi.org/10.1186/s40461-025-00187-3
28. Hausmann AC, Kleinert C (2014) Berufliche Segregation auf dem Arbeitsmarkt: Männer- und Frauendomänen kaum verändert. IAB-Kurzbericht 9/2014. Institut für Arbeitsmarkt- und Berufsforschung, Nürnberg
29. Hensge K, Schreiber D, Lorig B (2009) Kompetenzorientierung in der Berufsausbildung – Wege zur Gestaltung kompetenzbasierter Ausbildungsordnungen. Berufsbildung Wissenschaft und Praxis 38:18–22
30. Kambourov G, Manovskii I (2009) Occupational specificity of human capital. Int Econ Rev 50:63–115. https://doi.org/10.1111/j.1468-2354.2008.00524.x
31. Kiener F, Eggenberger C, Backes-Gellner U (2024) The role of occupational skill sets in the digital transformation: how IT progress shapes returns to specialization and social skills. J Bus Econ 94:75–111. https://doi.org/10.1007/s11573-023-01153-9
32. Koneberg F, Rohrbach-Schmidt D, Friedrich A (2026) Skill profiles of training occupations and occupational segmentation of vocational education and training in Germany. J Vocat Educ Train 78:331–349. https://doi.org/10.1080/13636820.2025.2549887

33. Kübler D, Schmid J, Stüber R (2018) Gender discrimination in hiring across occupations: a nationally-representative vignette study. Labour Econ 55:215–229. https://doi.org/10.1016/j.labeco.2018.10.002
34. Langer C, Wiederhold S (2023) The value of early-career skills. CESifo Working Paper No. 10288. CESifo, Munich
35. Menze L (2017) Horizontale und vertikale Adäquanz im Anschluss an die betriebliche Ausbildung in Deutschland: Zur Bedeutung von Merkmalen des Ausbildungsberufs. Kölner Z Soziol Sozialpsychol 69:79–107
36. Minssen L, Levels M, Pfeifer H, Wehner C (2025) Are recruiters driving gender segregation? Evidence from the German apprenticeship market. Ger J Hum Resour Manag 39:336–366. https://doi.org/10.1177/23970022241300060
37. NEPS Network (2025) National Educational Panel Study, Scientific Use File of Starting Cohort Grade 9, version 15.0.0. Leibniz Institute for Educational Trajectories, Bamberg. https://doi.org/10.5157/NEPS:SC4:15.0.0
38. Pawlowsky-Glahn V, Buccianti A (eds) (2011) Compositional data analysis: theory and applications. Wiley, Chichester
39. Pfahl S, Unrau E, Lindhorn A (2025) Frauen und Männer in den 25 häufigsten Ausbildungsberufen 2023. WSI GenderDatenPortal. Wirtschafts- und Sozialwissenschaftliches Institut der Hans-Böckler-Stiftung, Düsseldorf
40. Polachek SW (1981) Occupational self-selection: a human capital approach to sex differences in occupational structure. Rev Econ Stat 63:60–69. https://doi.org/10.2307/1924218
41. Protsch P (2013) Höhere Anforderungen in der beruflichen Erstausbildung? WSI-Mitt 66:15–22. https://doi.org/10.5771/0342-300X-2013-1-15
42. Salomons A, vom Baur C, Zierahn-Weilage U (2025) Expertise at work: new technologies, new skills, and worker impacts. IZA Discussion Paper No. 18248. IZA Institute of Labor Economics, Bonn. https://www.iza.org/publications/dp/18248
43. Scharnhorst U, Kaiser H (2018) Transversale Kompetenzen: Bericht im Auftrag des Staatssekretariats für Bildung, Forschung und Innovation SBFI im Rahmen des Projekts „Berufsbildung 2030 – Vision und Strategische Leitlinien. Staatssekretariat für Bildung, Forschung und Innovation, Bern
44. Spitz-Oener A (2006) Technical change, job tasks, and rising educational demands: looking outside the wage structure. J Labor Econ 24:235–270. https://doi.org/10.1086/499972
45. Tam T (1997) Sex segregation and occupational gender inequality in the United States: devaluation or specialized training? Am J Sociol 102:1652–1692. https://doi.org/10.1086/231129
46. Trappe H (2006) Berufliche Segregation im Kontext: Über einige Folgen geschlechtstypischer Berufsentscheidungen in Ost- und Westdeutschland. Kölner Z Soziol Sozialpsychol 58:50–78. https://doi.org/10.1007/s11575-006-0003-z

47. Vicari B (2018) Der Einfluss strukturierender Eigenschaften von Berufen auf horizontale und vertikale berufliche Mobilität im Kohortenvergleich. IAB-Discussion Paper 25/2018. Institut für Arbeitsmarkt- und Berufsforschung, Nürnberg

Figures

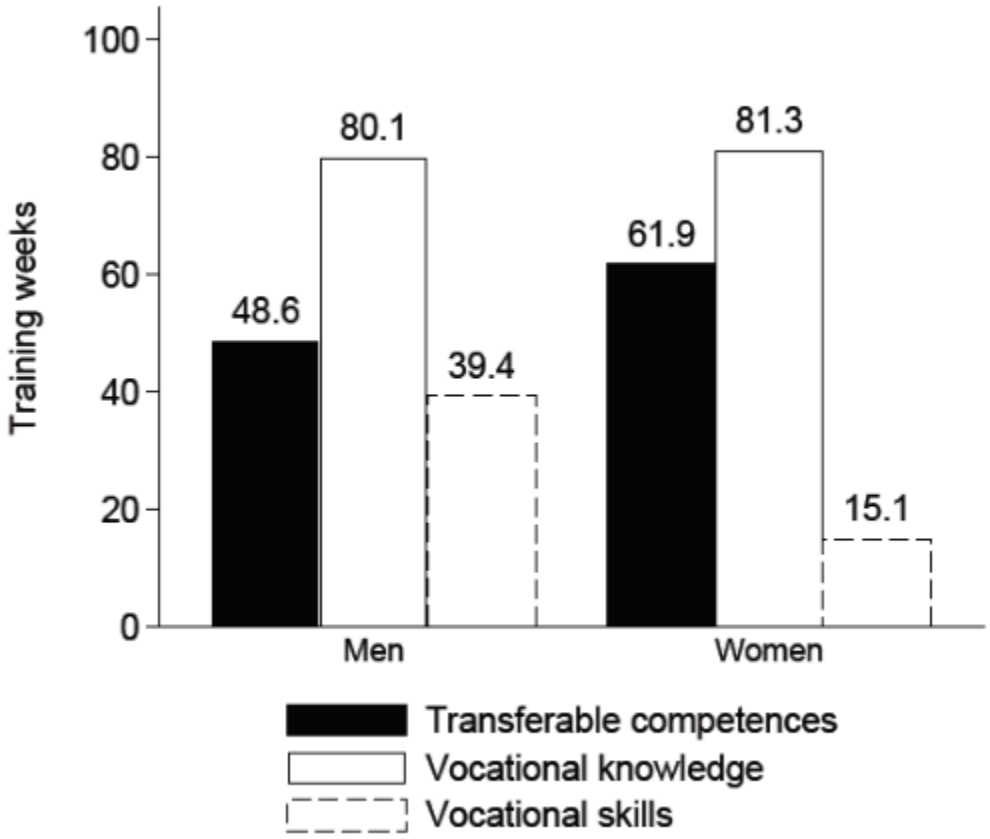


Figure 1

Prescribed curricular learning time by gender (descriptive means).

Legend: Average prescribed training weeks in transferable competences, vocational knowledge, and vocational skills for the occupations entered by women and men.

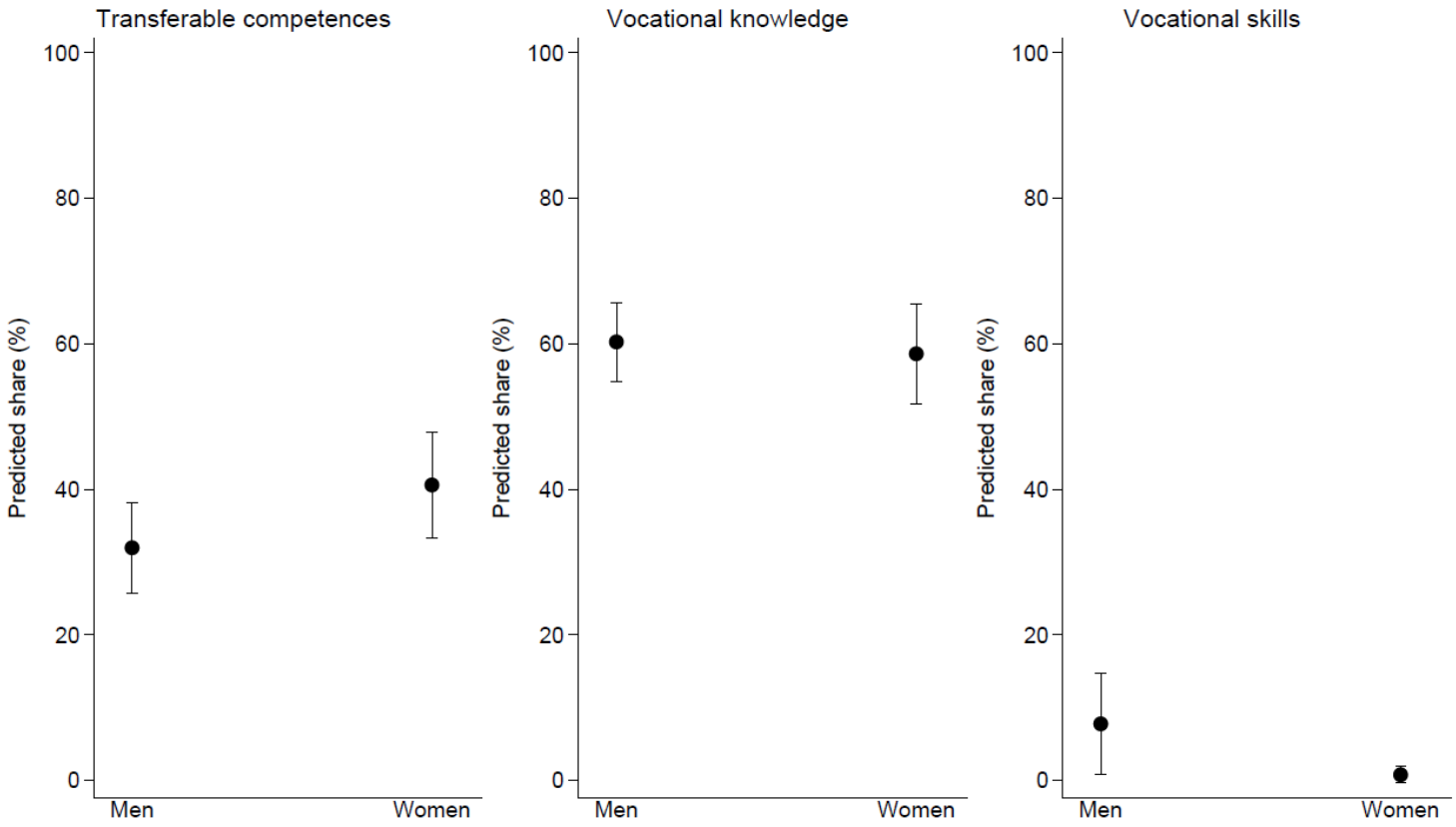


Figure 2

Adjusted predicted composition of curricular content by gender.

Legend: Approximate shares from Model 4 as reported in Section 6.2.