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Horizontal and vertical occupational gender segregation in German occupational orientation textbooks

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Abstract

Women continue to predominate in healthcare, early education, domestic work (HEED), and service occupations, whereas men dominate in science, technology, engineering, and mathematics (STEM) and skilled trades occupations globally. Educational materials can influence adolescents' career aspirations and play a crucial role in reinforcing or challenging occupational segregation. Although previous studies have documented gender representation in textbooks broadly, analyses of occupational orientation materials that examine both horizontal and vertical segregation in a differentiated manner are lacking. We analyzed 19 German secondary school textbooks from subjects focused on occupational orientation (Economics and Careers and Economics and Communication), assessing the gender distribution across different occupational domains and hierarchical levels in 1,195-character portrayals (959 textual, 236 visual). Results revealed that women were depicted significantly less frequently than men overall, primarily due to textual representations. Regarding horizontal segregation, women were overrepresented in HEED/service occupational roles (64.0%), while men dominated STEM/skilled trades occupational roles (77.9%). Vertical occupational segregation was only found in textual representations. Within female-dominated occupational domains, women were disproportionately represented in low-status roles, comprising 78.7% of characters at that level. Within male-dominated occupational domains, men were significantly overrepresented across all hierarchy levels, with the disparity being most pronounced at the lowest hierarchy level, where no women were depicted. These results suggest the need to revise educational materials, offering a constructive perspective for creating more equitable gender representations in occupational fields that can genuinely expand adolescents' career horizons.

Keywords Occupational gender segregation · HEED · STEM · Gender stereotypes · Textbooks

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1 Introduction

Women and men continue to work in markedly different occupations and hold unequal positions within organizational hierarchies across global labor markets (England et al., 2020; Torre & Jacobs, 2021). Despite decades of legislative reforms and growing awareness of gender equality, this segregation remains remarkably stable: women still are concentrated in occupational roles in health care, early education, domestic work (HEED), and service occupations, while men dominate science, technology, engineering, mathematics (STEM) professions, and skilled trades (World Economic Forum, 2023). This horizontal division combines with vertical segregation, as men hold disproportionate numbers of leadership and high-level positions even within female-dominated occupational domains (OECD, 2023). These disparities drive persistent wage gaps, restrict career advancement opportunities, and reinforce societal gender stereotypes (Blackburn & Jarman, 2006).

Educational materials contribute to occupational segregation during adolescence, a period when career aspirations crystallize, and gender role perceptions solidify (Eccles, 2011). Textbooks, as educational materials used almost daily, serve as powerful socializing agents that shape students' understanding of occupational possibilities and social norms (Apple & Christian-Smith, 1991). How these materials portray gender in occupational roles may therefore play an important role in shaping young people's perceptions of career appropriateness and their professional aspirations (Good et al., 2010; Olsson & Martiny, 2018; Scott & Feldmann-Summers, 1979).

However, critical gaps remain in our understanding of how contemporary educational materials portray occupational gender segregation. Three key limitations characterize existing research. First, although studies document women's general underrepresentation in occupational roles (Moser, 2016; Ott, 2021), few have systematically examined horizontal segregation, i.e., the concentration of gender in specific occupations, using contemporary domain classifications like HEED, STEM, services, and skilled trades that reflect current labor market divisions ([blinded for review]; Kerkhoven et al., 2016). Second, vertical segregation, which refers to the distribution of gender across hierarchical occupational levels, has received insufficient attention (Ott, 2017). Third, researchers have examined textbooks from various subjects, but have neglected specialized occupational orientation textbooks that address students' understanding of occupational possibilities.

We address these limitations by conducting a content analysis of officially approved German secondary-school textbooks for occupational orientation that examines both horizontal and vertical occupational gender segregation, using contemporary occupational domain classifications. Our results help determine whether contemporary occupational orientation textbooks reflect or challenge existing occupational gender segregation, providing crucial insights for developing more equitable educational resources that support diverse career aspirations during adolescence.

1.1 The role of curricula and textbooks in occupational orientation

Curricula function as state instruments for directing and standardizing education, specifying essential content, learning objectives, and competencies for different sub-

ject areas, school types, and grade levels (Stevenson & Baker, 1991). These frameworks articulate educational goals while embedding societal values, educational philosophies, and political priorities that shape students' learning experience (Apple, 2019; Moore, 2015; Young & Muller, 2016).

Many curricula, particularly at the secondary level, include occupational orientation to prepare students for future professional and personal life by providing information about diverse career paths, developing job-relevant skills, and drawing connections between education and employment (Guichard, 2001). For instance, the curriculum of the German Federal State of Bavaria explicitly prioritizes occupational orientation to facilitate informed career decisions and successful transitions into vocational training or further education (ISB, 2025). This curricular focus is implemented through textbooks in core subjects specifically designated for career guidance, such as Economics and Careers (*Wirtschaft und Beruf*) and Economics and Communication (*Wirtschaft und Kommunikation*).

Textbooks enable the practical implementation of these curricula's contents, serving as the primary resource for both teachers and students (Gautschi, 2018; Stará et al., 2017). They translate official guidelines into practical instructional materials, including texts, exercises, and illustrations, that structure teaching and learning and thus function as important mediators between official learning goals and classroom practice (Schmidt et al., 1997).

As relevant socializing agents, textbooks are widely argued to shape students' learning experiences and their understanding of the world (Apple & Christian-Smith, 1991; Tyson-Bernstein, 1988). Foundational work in this area posits that the ways these materials portray social groups and occupational roles influence students' understanding of social norms, their beliefs, and their identity formation (Behnke, 2018; Curdt-Christiansen, 2017). There is also a growing body of experimental research that supports this link. For instance, studies from psycholinguistics have shown that the use of gender-fair language in occupational descriptions can influence children's and adolescents' perceptions of those roles (Horvath et al., 2015; Vervecken et al., 2015; Vervecken & Hannover, 2015), and experimental studies have found that counter-stereotypical images can impact student performance (Good et al., 2010). Given that portrayals of occupational roles and domains often reflect traditional gender stereotypes (Arnot, 2002; Moser, 2016; Ott, 2021), it seems plausible that textbooks might perpetuate gender disparities through the subtle signals they send about who belongs in which occupational roles.

Through the theoretical lens of Social Role Theory (Eagly, 1987; Eagly & Wood, 2012) and Gottfredson's Theory of Circumscription, Compromise, and Self-Creation (Gottfredson, 2002), gendered representations in textbooks contribute to the internalization of occupational stereotypes during adolescence. When educational materials predominantly depict women and men in traditional roles, they reinforce perceptions that certain occupations suit one gender more than another, thus potentially limiting adolescents' occupational aspirations and shaping their career choices (Eccles, 2009; Weisgram et al., 2010). Analyzing gender representation in textbooks, particularly those addressing occupational orientation, is therefore essential for elucidating their potential impact on students' career aspirations and the reproduction of gender disparities.

1.2 Horizontal and vertical gender occupational segregation and their depiction in textbooks

Occupational gender segregation, the systematic concentration of women and men in different occupations and hierarchical positions, persists across contemporary labor markets (Jarman et al., 2012; Wong & Charles, 2020). As Schmader and Nater (2025) delineate, this segregation manifests in two interconnected yet distinct dimensions: horizontal and vertical segregation. Horizontal segregation refers to the unequal distribution of women and men across various occupations and industries. In contrast, vertical segregation refers to the uneven distribution across hierarchical levels within the same occupation, with men typically occupying higher-status, better-compensated positions. This section examines each segregation dimension by reviewing the existing literature and identifying research gaps.

1.2.1 Horizontal occupational gender segregation

Female-dominated occupational domains cluster primarily in two major categories: HEED (health care, early education, and domestic work) and broader service occupations (ILO, 2018; World Economic Forum, 2023). HEED roles involve care, nurturing, and social support functions, including nursing, teaching, and social work, while service occupations encompass retail, administrative, hospitality, and customer service roles such as secretaries, sales associates, and restaurant staff (Croft et al., 2015). These roles are associated with stereotypically feminine attributes like nurturing, warmth, and empathy (Froehlich et al., 2020; Sczesny et al., 2018), which align with what research identifies as communal attributes—qualities related to social connection, empathy, and helpfulness that are stereotypically attributed more strongly to women (Abele et al., 2016; Sczesny et al., 2018). Beyond their alignment with gender stereotypes, these occupational roles fulfill essential functions in health support, individual development, and community cohesion.

Labor market data demonstrate the extent of horizontal segregation, specifically the overrepresentation of females in these domains. Globally, women constitute approximately 70% of the health and social work workforce (Boniol et al., 2019). Similar patterns emerge nationally: for example, women comprise 74% of education and health services workers in the U.S.; in Germany, this figure reaches 77% (Bundesagentur für Arbeit, 2024; U.S. Bureau of Labor Statistics, 2023). This high female participation extends to the broader service domain in some countries (World Economic Forum, 2023). For example, national data show that women comprise approximately 65% of the general services workforce in Germany (Bundesagentur für Arbeit, 2024).

In contrast, male-dominated occupational domains center on STEM (science, technology, engineering, and mathematics) and skilled trades (World Economic Forum, 2023). STEM encompasses a range of occupations from research scientists, engineers, and computer professionals to specialized technicians (Fayer et al., 2017). Skilled trades include work in construction, manufacturing, and mechanics (National Center for Science and Engineering Statistics, 2023). These occupational domains are culturally associated with agency, which refers to attributes such as assertive-

ness, technical competence, and independence—qualities stereotypically ascribed to men (Abele et al., 2016; Abele & Wojciszke, 2007). These domains embody what Cheryan and Markus (2020) called "masculine defaults," referring to environments and systems created by and for one gender that contain subtle signals of inclusion for men and exclusion for women.

In STEM domains, despite concerted efforts to increase female participation, women account for only 29% of the global workforce (World Economic Forum, 2023). National figures are lower in many countries. For example, in the U.S., only 18% of women work in STEM domains (National Science Board & National Science Foundation, 2024) and 17% in Germany (Bundesagentur für Arbeit, 2024). Skilled trades show similar male dominance, with women comprising only around 22% of the workforce worldwide (World Economic Forum, 2023), and even lower numbers in some countries (e.g., 11.0% women in the U.S. construction workforce and 12% in Germany; Bundesagentur für Arbeit, 2024; U.S. Bureau of Labor Statistics, 2023).

1.2.1.1 Research on horizontal segregation in textbooks Previous studies examining horizontal segregation in educational materials consistently demonstrated that textbooks reflect the gendered division of occupations (Finsterwald & Ziegler, 2007; Moser & Hannover, 2014; Ott, 2017). Early investigations predominantly used terms like "typical" or "traditional" female/male occupational domains without using contemporary domain classifications like HEED or STEM, showed that women were mainly depicted in teaching, nursing, and secretarial work, while men appeared in broader ranges involving authority and technical skills (Evans & Davies, 2000; Lindner & Lukesch, 1994; Weitzman et al., 1972). For example, Lindner and Lukesch (1994) conducted a content analysis of 72 textbooks from Germany published between 1971 and 1992, covering German language arts, mathematics, basic sciences, and religion in primary and secondary education. Their analysis found significant horizontal segregation. Among 9,471 individuals depicted, women constituted only 32% of all characters. Their representation in occupational roles was disproportionately low, with only 13%. Among the 2,225 coded occupational roles, a clear gendered division emerged: 35% were typically female occupations (e.g., social care, sales, and hairdressing), in which women accounted for 62%. In contrast, 36% were in typical male occupations (including doctors and police), with only 12% of women depicted. The disparity was also evident in the images: among 6,992 individuals depicted, females accounted for 39%. Among the 797 coded occupational roles depicted in pictures, women accounted for only 16%.

Finsterwald and Ziegler (2007) reported similar results in their analysis of approximately 300 illustrations from 28 German-language arts and basic sciences textbooks for grades 1–4, published in Germany between 1996 and 2001. They observed significant male dominance in illustrations (59% male vs. 40% female). Adult men were more frequently depicted in occupations ($n = 210$) than women ($n = 74$), excluding the homemaker role. Within these occupational depictions, the distribution was asymmetric: 59% of the men ($n = 124$) appeared in male-dominated roles, while 93% of the women ($n = 69$) appeared in female-dominated roles. A notable crossover was observed for men, with 41% ($n = 86$) shown in female-dominated occupations,

whereas only 7% of women ($n = 5$) were depicted in male-dominated fields. The most frequent examples of male-dominated roles in which men appeared were craftsmen, farmers, and drivers, while female-dominated roles were most often teachers, saleswomen, nurses, and secretaries. A key finding concerns the gendered portrayal of technology use within occupations: Women were overwhelmingly depicted in situations requiring little to no technical knowledge, whereas men appeared in roles demanding moderate to high technical knowledge. While this study revealed a clear occupational segregation, its focus on general occupational categories rather than contemporary occupational classifications, such as HEED and STEM, limits direct comparisons with contemporary segregation frameworks.

In a linguistic analysis of 88 German-language and mathematics textbooks from Germany (and its predecessor states) from 1890 to 2013, Ott (2017) found that occupational activity was consistently portrayed as a male domain. At the lexical level, male-referring occupational terms appeared twice as frequently as female-referring terms. Certain occupational domains, such as those related to entrepreneurship, finance, construction, transport, law, military/police, and politics, were almost exclusively male-dominated. Men were frequently depicted in occupations that required heavy physical labor, such as craftsmen and laborers. In contrast, women were often depicted in occupations typically associated with nurturing or caregiving, such as teaching and nursing. Ott's study also highlighted that women were less frequently associated with technical devices. At the same time, men were predominantly shown using technical objects that required advanced technical knowledge, complex transportation means, and weapons. Although Ott's historical analysis provided valuable insights into gendered occupational discourse, the absence of specific HEED and STEM categorization makes it challenging to assess horizontal segregation within these critical domains.

Only a few studies used the contemporary categorizations of HEED and/or STEM when investigating horizontal occupational segregation in educational materials. Kerkhoven et al. (2016) conducted a visual content analysis of 333 online science education resources from the websites of Scientix (an EU-wide initiative) and OER-commons (a global library) for primary schools, analyzing 3,191 depicted individuals across astronomy, biology, chemistry, geology, mathematics, physics, and technology materials. The study revealed pronounced horizontal segregation: for example, men accounted for 75% of those depicted in science occupations, whereas women accounted for 25%. In contrast, females were more often depicted in teaching roles (classified as non-STEM by the authors) than men (64% versus 36%). While this study demonstrated gender segregation in STEM and non-STEM occupations, it did not analyze gender segregation within HEED occupational domains. Furthermore, it investigated online resources rather than textbooks. [blinded for review] employed quantitative text analysis of 202 current German language arts textbooks from Germany, using systematic occupational classifications to examine STEM and care work (HEED) occupational terms. Their findings revealed pronounced horizontal segregation in STEM occupations, with men comprising 86% and women 14%. Unexpectedly, men were also overrepresented in care work occupations (74% vs. 26% women), suggesting that employment is portrayed as predominantly masculine. While this study represents the first systematic examination of both HEED and

STEM in German language arts textbooks, the analysis focused on textual content, limiting insights into both visual representations and the specific activities or contexts associated with occupational portrayals.

1.2.1.2 Research gaps in textbook research on horizontal segregation Despite this established body of research, several gaps remain in our understanding of horizontal segregation in textbooks. First, older studies typically categorized occupations as predominantly female or predominantly male (Lindner & Lukesch, 1994; Weitzman et al., 1972). And, although there has been a shift in recent years to use more systematic, contemporary classifications (Asadullah et al., 2018; Crawfurd et al., 2024; Fruehwirth et al., 2024; Jehle et al., 2024), a comprehensive analysis that includes HEED and STEM as well as the gendered occupational domains of services and skilled trades is still a desideratum in the literature. Second, existing research has predominantly examined general subject textbooks (Cruz Neri et al., 2024; Jehle et al., 2024; Moser & Hannover, 2014; Ott, 2017) or other educational media. To our knowledge, a systematic analysis of specialized occupational orientation textbooks, materials with an explicit curricular mandate to guide students' career choices, is still lacking. Given that these materials are central to career preparation, this represents a significant gap. Third, many studies have analyzed either textual content (Fruehwirth et al., 2024) or visual representation (Finsterwald & Ziegler, 2007; Kerkhoven et al., 2016) in isolation. A key goal of the present study is to address these gaps by systematically analyzing both text and images in specialized career orientation textbooks, using a comprehensive four-part domain classification (HEED, services, STEM, and skilled trades).

1.2.2 Vertical occupational gender segregation

Vertical occupational gender segregation refers to the hierarchical dimension of occupational inequality, characterized by the unequal distribution of women and men across levels of authority, responsibility, and compensation within occupational domains (Blackburn et al., 2001). This form of segregation manifests as women's underrepresentation in positions of leadership and power, with men typically dominating high-level roles even when women constitute significant portions of the overall workforce within those domains. Despite progress toward greater gender equality, women advance to top leadership positions at lower rates than men, with disparities evident across both political and economic spheres (Blau & Lynch, 2024). Unlike horizontal segregation, which separates occupational domains by gender, vertical segregation creates hierarchical barriers within domains, limiting women's advancement to higher positions despite their numerical presence in those domains (Perales, 2013; Schmader & Nater, 2025).

Vertical gender segregation persists even within female-dominated occupational domains. While women comprise nearly 70% of the global health workforce, they hold only 25% of senior leadership roles (ILO & World Health Organization, 2022; World Health Organization, 2019). Similar patterns emerge at the country level. For example, in the U.S. health care sector, women constitute 62% of the overall work-

force but hold only 44% of senior leadership positions. Similarly, in education, their share drops from 54% of the workforce to 44% at the leadership level (Lara & Baird, 2024). In Germany, women comprise 78% of the workforce in female-dominated occupational segments (such as the medical and non-medical health sector and social and cultural service occupations) but hold only 52% of leadership positions in these domains.

Vertical segregation in male-dominated STEM and skilled trades presents a paradox that challenges simple exclusion narratives. While women comprise only 29% of the global STEM workforce, reflecting severe horizontal segregation at entry (World Economic Forum, 2023), vertical progression for women who do enter these domains shows considerable cross-national variation. Global aggregated data suggests continued underrepresentation at senior levels, with women holding 18% of senior leadership and 12% of top executive roles (World Economic Forum, 2023). However, national data reveal a more complex picture. In the U.S. federal sector, women hold 25.9% of STEM leadership positions, compared with 29.3% of the overall STEM workforce (EEOC, 2019). In Germany, although women are underrepresented in male-dominated technical occupations (Bundesagentur für Arbeit, 2024), they significantly outperform their male colleagues in advancement: 35.3% of women reach specialist (with complex work activities) or expert (with highly complex work activities) levels compared to only 27.5% of men in the same domain (Vicari et al., 2023).

1.2.2.1 Research on vertical segregation in textbooks Compared with general occupational gender representation and horizontal segregation, vertical segregation has received considerably less attention in textbook research (Moser, 2016; Ott, 2021). Some studies have investigated related issues and have yielded inconsistent findings (Finsterwald & Ziegler, 2007; Ott, 2017).

Finsterwald and Ziegler (2007) found no significant gender differences regarding the general depiction of dominance in social situations. Women were shown in dominant roles, such as instructing others, almost as frequently as men (women were coded as "dominant" in 63% of applicable situations, with no statistically significant difference from men), challenging stereotypes of female submissiveness. A different picture emerged for educational attainment as implied by occupations. Men were more frequently depicted in occupations that required no specific diploma or a basic secondary school education, often involving physical labor. Specifically, the percentage of men shown in jobs requiring no diploma was 16.5% points higher than the percentage of women shown in such jobs. Similarly, for jobs requiring a basic secondary school diploma, the male share was 10.5% points higher than the female share. In contrast, women were more likely to be depicted in occupations requiring university degrees (a 17.2%-point overrepresentation relative to men). While this was among the first studies to examine vertical segregation, the analysis employed indirect measures, such as educational attainment, and focused on behavior rather than conducting a systematic examination of hierarchical job titles or compensation.

In an extensive study, Ott (2017) identified more pronounced vertical segregation through discourse-linguistic analysis of 88 German textbooks published between 1890 and 2013. Based on a qualitative interpretation of occupational titles, Ott found

that male job titles consistently spanned broad hierarchical ranges, often using explicit leadership markers (e.g., suffixes denoting "master" or "leader"). In contrast, female titles lacked these markers, with status distinctions shown through separate words (e.g., "farm owner" vs. "farmhand"). Women first appeared in leadership roles in the 1960 s, initially restricted to female-dominated occupational domains, and were frequently portrayed in subordinate roles, such as secretaries, particularly from the 1980 s to the 2000s. While providing rich qualitative insights, Ott's linguistic focus lacked a systematic quantitative framework for analyzing vertical segregation across predefined occupational hierarchical levels.

More recently, Guichot-Reina and La Torre-Sierra (2023) conducted a critical discourse analysis of six current Spanish elementary mathematics textbooks that explicitly documented vertical segregation. The study showed that when characters were depicted in high-status occupational positions such as bosses, directors, or mayors, men occupied these roles 69% of the time, whereas women occupied them 31% of the time. These hierarchical differences in occupations were reinforced through qualitative examples, such as a male headmaster supervising a female teacher. Although employing a comprehensive classification of occupational status levels, the study focused explicitly on high-status roles.

1.2.2.2 Research gaps in vertical segregation in textbooks Although existing research on vertical segregation in gender-stereotypical occupational representation in textbooks gives some important insights, several research gaps remain. First, to our knowledge, no study has investigated vertical segregation within contemporary occupational domains, such as HEED and STEM, nor examined whether textbooks accurately reflect the nuanced pictures of women's advancement documented in contemporary labor market studies, or present oversimplified narratives that may not align with empirical evidence. Second, the conceptualization of vertical segregation is often methodologically simplistic and lacks firm theoretical grounding. Studies have employed indirect categories, such as educational attainment (Finsterwald & Ziegler, 2007), or basic counts of high-status titles (Guichot-Reina & La Torre-Sierra, 2023), rather than applying a systematic classification of occupational vertical segregation. Third, as with gaps in research on horizontal segregation, analyses have focused on general subject textbooks (Moser & Hannover, 2014; Ott, 2017) rather than specialized occupational orientation materials designed to support career choices. Finally, most studies analyze either textual or visual representations in isolation, overlooking the interplay between language and images in the construction of hierarchical occupational gender roles.

2 Current study

Past research on textbooks reveals significant gaps in understanding both the horizontal and vertical dimensions of occupational gender segregation. Although a vast body of research exists on horizontal segregation, most studies used broad occupational categories (e.g., "typically female" vs. "typically male") rather than contempo-

rary classifications, such as HEED and STEM. Research on vertical segregation has only received limited attention, with the few studies examining hierarchical gender segregation focusing on simplistic vertical categories. Furthermore, a simultaneous investigation of both text and images is lacking. Finally, existing research has predominantly focused on general subject textbooks rather than specialized textbooks for occupational orientation. These gaps are particularly significant given that occupational orientation textbooks provide adolescents with essential guidance during a developmental period when occupational aspirations solidify, thus potentially reinforcing gender stereotypes that contribute to persistent occupational gender segregation (Eccles, 2011; Korlat et al., 2023). To address these limitations, the current study systematically examines both horizontal and vertical occupational gender segregation in German secondary school occupational orientation textbooks, materials specifically designed to meet curricular specifications for career orientation and guidance. Based on current gender distributions in national and international labor markets, we investigate horizontal segregation by categorizing occupations into female-dominated occupational domains, such as HEED occupations and services, and male-dominated occupational domains, such as STEM occupations and skilled trades. We investigated vertical segregation by classifying occupations within each domain into three hierarchical levels (low, medium, and high) based on sociological frameworks and standardized occupational classification systems that incorporate factors such as required qualifications, responsibility level, and typical remuneration (Blackburn et al., 2014; Bundesagentur für Arbeit, 2021; ILO, 2023). We investigate horizontal and vertical gender occupational representation in both text and images.

Given the extensive literature documenting persistent occupational gender imbalances, with women being less frequently depicted than men in occupational roles (Ott, 2021), we hypothesize:

Hypothesis 1 *Women are depicted less frequently than men in occupational roles in German occupational orientation textbooks.*

Concerning horizontal segregation, given that HEED and services domains are typically female-dominated, and STEM occupations and skilled trades are typically male-dominated (Tellhed et al., 2017), we hypothesize:

Hypothesis 2 *Women are depicted more frequently within female-dominated occupational domains (HEED and services) and less frequently within male-dominated occupational domains (STEM and skilled trades).*

Concerning vertical segregations, due to existing research and the tendency for men to occupy and be associated with higher-level positions (Blackburn et al., 2014), we hypothesize:

Hypothesis 3a *In female-dominated occupational domains (HEED and services), men are disproportionately represented in high-level occupational roles, while women are disproportionately represented in low- and medium-level occupational roles.*

Hypothesis 3b *In male-dominated occupational domains (STEM and skilled trades), men are disproportionately represented at all occupational levels (high, medium, and low).*

To test our hypotheses, we conducted a content analysis of German secondary school occupational orientation textbooks, encompassing both text and images. We then employed descriptive and inferential statistical analyses to examine the resulting frequency data in relation to our hypotheses.

3 Method

3.1 Sample

The study sample comprised 19 German secondary school textbooks explicitly designed for occupational orientation education and officially approved between 2017 and 2022. These textbooks are used in Bavaria, one of Germany's 16 federal states, which maintains a three-track secondary education system: an academic track preparing for university (Gymnasium), an intermediate track (Realschule), and a vocational-oriented track (*Mittelschule)*. We focused on textbooks from the vocational-oriented track (*Mittelschule)* because this educational pathway places the strongest emphasis on occupational orientation and practical career preparation, with students typically transitioning directly to vocational training or employment after graduation.

We selected textbooks based on three criteria: (a) official approval by the Bavarian State Ministry for Education and Cultural Affairs, (b) explicit coverage of occupational orientation competencies as specified in the Bavarian curriculum (*LehrplanPLUS*) through the two core subjects designated for occupational orientation instruction in the vocational-oriented track (*Mittelschule*) curriculum: Economics and Careers (*Wirtschaft und Beruf*) and Economics and Communication (*Wirtschaft und Kommunikation*), and (c) publication after the 1986 German federal resolution promoting fair gender representation in educational materials (KMK, 1986), which mandated that textbooks present women and men equally in various social and occupational roles. The final sample comprised all available textbooks for these subjects: 14 from Economics and Careers (covering Grades 5–10) and five from Economics and Communication (covering Grades 7–10). Online Appendix A provides detailed characteristics of the textbook sample.

3.2 Coding instrument development

To code occupational representation concerning horizontal segregation (HEED/services, STEM/skilled trades) and vertical segregation (hierarchical occupational levels), we adapted a validated coding instrument developed initially by Moser et al. (2013) for analyzing gender representation in both textual and visual content in educational materials (Moser & Hannover, 2014). Based on qualitative content analysis principles (Mayring, 2014), we refined the coding framework to capture

detailed occupational portrayals while maintaining the original instrument's validated approach.

The original instrument comprises six scales for text and image coding, including categorization of text types and images, character identification, language analysis, actions, and locations of actions. For our adaptations, we retained the methodological approach and the scales for text/image categorization, character identification, and language analysis, particularly the validated procedures for gender identification. We excluded scales assessing actions and locations after pretesting revealed that they did not contribute to our research questions regarding occupational representation. Most significantly, we expanded the instrument by developing new scales to systematically capture occupations according to horizontal domains (HEED, services, STEM, skilled trades) and vertical segregation levels.

To ensure the content validity of our occupational coding (Neuendorf, 2011), we undertook two steps. First, we aligned our coding categories with both the official occupational classifications of the German Federal Employment Agency (Bundesagentur für Arbeit, 2021) and empirical evidence showing that HEED and STEM constitute opposing poles of occupational segregation (Croft et al., 2015; Fayer et al., 2017). Prior research indicates that textbooks frequently depict women in female-dominated domains while underrepresenting them in male-dominated domains (Ott, 2021). This alignment ensured that our occupational domains captured both current labor market structures and documented patterns of gendered occupational representation. Second, we constructed our vertical segregation scale based on theoretical frameworks addressing gender and work, incorporating hierarchical distinctions in qualification requirements, skill levels, income, and occupational prestige (Blackburn et al., 2002; Wong & Charles, 2020).

The unit of analysis was each character presented within a clear occupational context. For textual representations, we coded nouns or pronouns directly associated with occupational titles (e.g., "the engineer," "she is a nurse") or with descriptions of occupational activities (e.g., "she is treating patients"). For visual representations, we coded distinct human figures shown performing occupational tasks, wearing occupation-specific clothing (e.g., lab coats, hard hats), or situated in clearly occupational settings (e.g., hospitals, construction sites). We employed parallel coding procedures for text and images, using both shared categories (gender, occupational domain, vertical level) and modality-specific categories. Specifically, text-specific categories included linguistic gender markers and pronoun usage, while image-specific categories included visual gender cues and occupational symbols. When text and accompanying images clearly represented the same individual or occupational context (e.g., a caption reading "Dr. Schmidt" beneath an image of a person in medical attire), coders synthesized information from both modalities to assign consistent codes for gender identification, occupational domain, and vertical segregation level.

3.3 Coding categories

3.3.1 Gender categories scale

After identifying individual characters depicted in occupational contexts, we coded each character's gender separately using the following process. For textual depictions, we first determined the type of gender evidence (e.g., explicit gender-specific terms, specific personal names, or gender-fair language forms). Based on this evidence, we assigned characters to an initial category. Characters were coded as male (1) or female (2) when identified through explicit gendered terminology (e.g., *Frau*/*Mann* [woman/man]), clearly gendered personal names, or gender-specific grammatical forms (e.g., *der Bäcker* [the baker, masc.] for male[1]; *die Ärztin* [the doctor, fem.] for female). We assigned characters to a neutral/gender-fair (3) category when an intentionally inclusive or grammatically neutral German term was used (e.g., the neutral noun *Lehrkraft* [teaching staff], an abbreviated gender-inclusive form like *Lehrer/-in* [male/female teacher], or an explicit pairing like *eine Richterin oder ein Richter* [a female judge or a male judge]). In cases of ambiguity or insufficient information where a gender could not be determined (e.g., a unisex name like Alex [Alexandra/Alexander] without further cues), characters were coded as unassignable (0). For image depictions, we coded characters directly as male (1), female (2), or unassignable (0) based on visual cues and contextual information.

For the final statistical analyses, we consolidated these initial codes into a single four-level analytical variable, also referred to as the gender category. The unassignable category (0) included all characters coded as such from either text or images. The male category (1) and female category (2) likewise combined the respective codes from both modalities. The neutral/gender-fair category (3) consisted exclusively of characters identified as such from textual depictions. This consolidated gender category variable was used for all analyses reported in the Results section.

3.3.2 Horizontal occupational segregation scale

We initially planned to classify occupational roles depicted in texts and images into domains based on prior research (e.g., HEED, STEM, other). However, pretesting revealed that roles frequently coded as "other" were numerous and clustered into distinct occupational types. Consequently, drawing inductively from the material during the pretest phase, we refined the coding scheme to include five primary domains: HEED (health care, early education, domestic work; code 1), STEM (science, technology, engineering, mathematics; code 2), skilled trades (e.g., bricklayers, electricians, carpenters; code 3), service occupations (e.g., retail sales staff, secretaries, hairdressers; code 4), and other domains (e.g., athletes, truck drivers, farmers; code 5). Roles that could not be classified were marked as "unassignable" (code 0).

[1] We acknowledge the linguistic debate regarding the *generic masculine* in German (Stahlberg et al., 2007), where a grammatically masculine noun (e.g., *der Lehrer*, [male teacher]) can be intended to refer to individuals of any gender. Our initial coding scheme included a category for this, but no instances in our sample could be unambiguously identified as generic. Therefore, for coding consistency, all grammatically masculine occupational titles were operationally coded as "male".

For statistical analysis, we aggregated these domains into contemporary occupational categories that reflect documented gender-stereotyped occupational distributions. We combined HEED and service occupations into "female-dominated occupational domains" (FDOD), and STEM and skilled trades into "male-dominated occupational domains" (MDOD). These aggregated categories (FDOD and MDOD) are used throughout the Results section.

3.3.3 Vertical occupational segregation scale

Following sociological frameworks (Blackburn, 2012; Wong & Charles, 2020) and aligning with the German Federal Employment Agency's classifications (Bundesagentur für Arbeit, 2021), we categorized occupational roles according to vertical segregation criteria, including hierarchical level, qualification requirements, compensation indicators, and societal status. We distinguished three hierarchical levels (high, medium, low) using the following criteria:

3.3.3.1 High-level This category encompasses leadership roles, positions that involve substantial responsibility and complex decision-making, with high qualification requirements (typically university degrees or master craftsperson certification) and high societal status/income (e.g., physicians, executives, master craftspeople, engineers in leadership roles).

3.3.3.2 Medium-level This category includes occupational roles and positions requiring intermediate responsibility, typically vocational training or bachelor's-level qualifications, professional tasks often without leadership functions, and average societal status/income (e.g., teachers, nurses, childcare professionals, mechanics, technicians).

3.3.3.3 Low level This category includes occupational roles and positions characterized by minimal responsibility, lower qualification requirements (often unskilled or semi-skilled), routine or simple tasks, and lower societal status/income (e.g., cleaning staff, assembly line workers, cashiers, entry-level service workers).

3.4 Data collection procedure

The final dataset comprised 1,195 coded instances of occupational roles extracted from 19 occupational orientation textbooks, consisting of 959 textual and 236 image representations. We obtained this dataset through the following procedure: First, we identified chapters that explicitly addressed occupations and work-related topics in each sampled textbook. Second, given the extensive nature of relevant content within these chapters, we employed a systematic random sampling strategy consistent with established content analysis methodologies (Neuendorf, 2011). Specifically, for the relevant chapters within each of the 19 textbooks, we first created a numbered list of

all page numbers eligible for sampling. We then used the Random.org random integer generator to generate a list of unique random numbers corresponding to 50% of the textbook's pages. The pages corresponding to these randomly generated numbers constituted the final sample for coding. This approach ensured proportional representation across all textbooks while managing coding workload. Finally, two trained coders coded all occupational characters (textual and visual) appearing on these selected pages according to the coding categories described above. Each appearance was coded as an independent instance (i.e., a token-based approach). For example, if the same character (e.g., "the engineer") appeared three times on a selected page, it was coded as three separate instances. This approach was chosen to capture the overall frequency of exposure to different types of gendered portrayals.

3.5 Interrater reliability assessment

We conducted a pretest using two textbooks randomly selected from the initial pool (which were subsequently excluded from the main analysis). The two trained coders, the first author and a student research assistant who had received training, collaboratively performed this pretest, refining the coding manual to ensure consistent interpretations and operational definitions of categories. The pretest focused on explicitly identifiable occupational characters, defined as individual figures in text or images associated with a named or visually implied occupation.

For the main analysis, these two trained coders analyzed all textual and visual data from the selected textbook pages. We evaluated interrater reliability using a randomly selected subsample of two textbooks consistent with established content analysis recommendations (Neuendorf, 2011). This subsample, representing 10% of the final sample and comprising 333 coded characters, was coded independently by both coders. After establishing high inter-rater reliability (detailed below), the remaining 90% of the material was divided between the two coders to complete the analysis. Any ambiguities encountered during this main coding phase were resolved through discussion to ensure consistency. We calculated interrater reliability using Cohen's kappa (Cohen, 1960; Fleiss, 1971) via the IRR package (Gamer et al., 2019) in R (version 4.4.2; R Core Team, 2024), supplemented by simple percentage agreement (See Table D1 in Online Online Appendix D for detailed kappa values and percentage agreement per coding category).

Cohen's kappa values for all coding categories ranged from 0.898 to 1.000. These values indicate excellent agreement according to conventional benchmarks ($\kappa > 0.80$ = excellent; $\kappa > 0.60$ = substantial; $\kappa > 0.40$ = moderate; Landis & Koch, 1977; Neuendorf, 2011).

3.6 Data analysis

We conducted all analyses using IBM SPSS Statistics 27, with a statistical significance level set at $\alpha = 0.05$. Descriptive statistics summarized gender category distributions (male, female, neutral/gender-fair, unassignable) across occupational domains and vertical segregation levels. We performed analyses on all occupational depictions

combined (total $N = 1{,}195$) as well as separately for textual (total $N = 959$) and image-based (total $N = 236$) representations, with specific subsamples detailed below.

To test Hypothesis 1 (H1: Women are depicted less frequently in occupational roles than men), we used chi-square goodness-of-fit tests to compare observed frequencies of "male" versus "female" characters against an expected equal distribution. We conducted this analysis on the combined sample ($N = 719$) and separately for the text ($n = 496$) and image ($n = 223$) subsets.

To test the hypotheses concerning horizontal segregation (H2: Women are depicted more frequently within female-dominated occupational domains (HEED and services) and less frequently within male-dominated occupational domains (STEM and skilled trades), we employed a two-step process. First, we conducted an initial omnibus Fisher-Freeman-Halton exact test (using a Monte Carlo simulation with 10,000 samples) to establish whether an overall association existed between gender category and the six original occupation categories. This omnibus test included all characters with identifiable gender and occupational domain ($N = 831$ combined; $n = 646$ text; $n = 185$ images). Second, to directly test H2, we performed Fisher's exact tests on 2×2 contingency tables that crossed the "male"/"female" categories with the FDOD/MDOD categories. These focused analyses excluded characters in "other domains" and "domain not specified" categories to examine gender distribution in clearly gender-typed occupational domains. Given the potential for small cell counts in some subgroups (e.g., within image representations), this exact test was deemed the most appropriate procedure (Agresti, 1992; Neuendorf, 2017). We conducted these focused tests for combined data ($N = 460$), and separately for text ($n = 325$) and images ($n = 135$). We used Cramer's V to quantify effect size.

For the vertical segregation hypotheses (H3a: In female-dominated occupational domains (HEED and services), men are disproportionately represented in high-level occupational roles, while women are disproportionately represented in low- and medium-level occupational roles, and H3b: In male-dominated occupational domains (STEM and skilled trades), men are disproportionately represented at all occupational levels (high, medium, and low), we conducted Fisher-Freeman-Halton exact tests on 2×3 contingency tables to assess associations between gender ("male"/"female") and segregation level ("high"/"medium"/"low"). We stratified these analyses by domain type and performed them within FDODs (combined $N = 242$; text $n = 162$; images $n = 80$) to test H3a (in female-dominated occupational domains (HEED and services), men are disproportionately represented in high-level occupational roles, while women are disproportionately represented in low- and medium-level occupational roles), and within MDODs (combined $N = 213$; text $n = 160$; images $n = 53$) to test H3b (in male-dominated occupational domains (STEM and skilled trades), men are disproportionately represented at all occupational levels (high, medium, and low). Significant omnibus tests were then followed by pairwise post-hoc Fisher's Exact tests to identify which specific levels differed significantly, using a Bonferroni-corrected alpha level of 0.017 for these three comparisons. For these focused tests, we obtained exact p-values directly via SPSS's METHOD=EXACT procedure, a method recommended to ensure the reliability of findings when analyzing contingency tables with sparse data (Agresti, 1992). We reported Cramer's V as the effect size for the initial omnibus tests.

Table 1 Gender distribution by occupational domain and representation type

Domain group	Gender	*N*	% within domain category
Combined (*N* = 1,195)			
Female-dominated occupational domains (FDOD)	M	89	21.1
	F	158	37.4
	N/GF	174	41.2
	U	1	0.2
	Subtotal	422	100.0
Male-dominated occupational domains (MDOD)	M	166	58.5
	F	47	16.5
	N/GF	65	22.9
	U	6	2.1
	Subtotal	284	100.0
Other domains	M	40	32.0
	F	34	27.2
	N/GF	46	36.8
	U	5	4.0
	Subtotal	125	100.0
Domain not specified	M	108	29.7
	F	77	21.2
	N/GF	168	46.2
	U	11	3.2
	Subtotal	364	100.0
Text (*N* = 959)			
Female-dominated occupational domains (FDOD)	M	61	18.0
	F	104	30.7
	N/GF	174	51.3
	Subtotal	339	100.0
Male-dominated occupational domains (MDOD)	M	124	55.1
	F	36	16.0
	N/GF	65	28.9
	Subtotal	225	100.0
Other domains	M	20	24.4
	F	16	19.5
	N/GF	46	56.1
	Subtotal	82	100.0
Domain not specified	M	76	24.3
	F	59	18.8
	N/GF	168	53.7
	U	10	3.2
	Subtotal	313	100.0
Image (*N* = 236)			
Female-dominated occupational domains (FDOD)	M	28	33.7
	F	54	65.1
	U	1	1.2
	Subtotal	83	100.0
Male-dominated occupational domains (MDOD)	M	42	71.2
	F	11	18.6
	U	6	10.2

Table 1 (continued)

Domain group	Gender	*N*	% within domain category
	Subtotal	59	100.0
Other domains	M	20	46.5
	F	18	41.9
	U	5	11.6
	Subtotal	43	100.0
Domain not specified	M	32	62.7
	F	18	35.3
	U	1	2.0
	Subtotal	51	100.0

M male, *F* female, *N/GF* neutral/gender-fair, *U* unassignable, *FDOD* female-dominated occupational domains (HEED + services), *MDOD* male-dominated occupational domains (STEM + skilled trades)

Fisher-Freeman-Halton exact tests: combined data, $p < .001$, Cramer's $V = 0.20$; text $p < .001$, Cramer's $V = 0.21$; images $p < .001$, Cramer's $V = 0.29$

For focused inferential tests of H2a/H2b (Male/Female in FDOD/MDOD), see the Results section

4 Results

This section is organized into two main parts. First, in the General Descriptive Findings section, we present the distribution of neutral/gender-fair language, occupational portrayals outside our main analytical categories, and overall gender distributions across all six occupational domains. Second, in the Inferential Analyses section, we describe the results of testing our hypotheses. We analyzed 1,195 occupational portrayals from 19 textbooks, with 959 textual and 236 visual representations. All analyses are presented first for the combined dataset, followed by analyses of the textual and visual representations. Tables 1 and 2 present descriptive frequencies and percentages for horizontal and vertical segregation analyses. Comprehensive frequency data for specific occupational domains are provided in Online Appendix B, and detailed data on vertical segregation levels are presented in Online Appendix C.

4.1 General descriptive findings

Of the 1,195 occupational portrayals in the combined dataset, 719 (60.2%) were explicitly coded as male or female. The remaining portrayals used either neutral or gender-fair language forms (37.9%, $n = 453$), a category applicable only to text, or had an unassignable gender (1.9%, $n = 23$).

This distribution varied by modality. Among the 959 textual representations, 496 (51.7%) were explicitly gendered, while a substantial portion used neutral or gender-fair language (47.2%, $n = 453$). In contrast, image representations ($N = 236$) could only be coded based on visual cues of gender. Of these, 223 (94.5%) characters were coded with a clearly identifiable gender (male or female). The remaining 13 characters (5.5%) were coded as unassignable because the visual information was ambiguous (e.g., distant figures, uniforms obscured by other objects, or stylized, non-detailed drawings).

Beyond the primary female-dominated occupational domain (FDOD) and male-dominated occupational domain (MDOD) categories central to our hypotheses, 125

Table 2 Gender distribution by vertical segregation level, domain, and representation type

Domain Category	Gender	Segregation: high	Segregation: medium	Segregation: low	Exact Test *p*-value	Cramer's V
		N (%)	*N* (%)	*N* (%)	*p*	
	Combined (Total *N* = 1,195)					
Female-dominated occupational domains (FDOD)	M	5 (38.5)	66 (44.6)	17 (21.0)	0.001	0.23
	F	8 (61.5)	82 (55.4)	64 (79.0)		
	Subtotal	13	148	81		
Male-dominated occupational domains (MDOD)	M	26 (61.9)	119 (79.9)	21 (95.5)	0.006	0.22
	F	16 (38.1)	30 (20.1)	1 (4.5)		
	Subtotal	42	149	22		
	Text (Total *N* = 959)					
Female-dominated occupational domains (FDOD)	M	4 (40.0)	46 (43.8)	10 (21.3)	0.026	0.21
	F	6 (60.0)	59 (56.2)	37 (78.7)		
	Subtotal	10	105	47		
Male-dominated occupational domains (MDOD)	M	25 (62.5)	82 (79.6)	17 (100.0)	0.004	0.25
	F	15 (37.5)	21 (20.4)	0 (0.0)		
	Subtotal	40	103	17		
	Image (Total *N* = 236)					
Female-dominated occupational domains (FDOD)	M	1 (33.3)	20 (46.5)	7 (20.6)	0.053	0.27
	F	2 (66.7)	23 (53.5)	27 (79.4)		
	Subtotal	3	43	34		
Male-dominated occupational domains (MDOD)	M	1 (50.0)	37 (80.4)	4 (80.0)	0.558	0.14
	F	1 (50.0)	9 (19.6)	1 (20.0)		
	Subtotal	2	46	5		

Percentages calculated within segregation levels

M male, *F* female, *FDOD* female-dominated occupational domains (HEED + services), *MDOD* male-dominated occupational domains (STEM + skilled trades)

Fisher-Freeman-Halton exact test *p*-values and Cramer's *V* shown

portrayals (10.5%) in the combined dataset depicted occupations assigned to the category "other domains" (e.g., athletes, farmers), comprising men ($n = 40$), women ($n = 34$), neutral/gender-fair ($n = 46$), and unassignable ($n = 5$) characters. This category contained 82 textual and 43 visual portrayals. In the combined dataset, 364 portrayals (30.5%) could not be assigned to specific occupational domains, comprising 313 (32.6%) textual and 51 (21.6%) visual representations.

Omnibus Fisher-Freeman-Halton exact tests examining all six occupational categories (HEED, STEM, skilled trades, services, other, unspecified) revealed significant differences in the gender distribution in the combined data ($p < .001$), text (p

<.001), and images (p <.001), indicating systematic gender differences across all occupational categories (see Online Appendix B for details).

4.2 Inferential analyses

4.2.1 Hypothesis 1: Women are depicted less frequently than men in occupational roles

In the combined sample, 719 characters were explicitly coded as either male or female. As hypothesized, men (56.1%, n=403) were depicted significantly more frequently than women (43.9%, n=316), $\chi^2(1, N=719)=10.53$, p =.001. This difference was mainly driven by differences in textual representations (N=496), where men (56.7%, n=281) appeared significantly more often than women (43.3%, n=215), $\chi^2(1, N=496)=8.78$, p =.003. In contrast, visual representations (N=223) showed no significant difference in the depiction of men (54.7%, n=122) and women (45.3%, n=101), $\chi^2(1, N=223)=1.98$, p =.160.

4.2.2 Hypothesis 2: Women are depicted more frequently within female-dominated occupational domains (HEED and services) and less frequently within male-dominated occupational domains (STEM and skilled trades)

To test the hypothesis concerning horizontal segregation, Fisher's exact tests were conducted on 2×2 contingency tables (Gender [Male/Female] × Domain Type [FDOD/MDOD]). As shown in Table 1, the analyses revealed a strong, significant association between gender and domain type across all datasets.

For the combined data set (N=460), the association was significant (Fisher's Exact p <.001, Cramer's V = 0.420). Consistent with the hypothesis, women were more likely to appear in female-dominated occupational domains (FDODs), where they constituted 64.0% of characters (n=158), compared to 36.0% men (n=89). In contrast, women were less likely to appear in male-dominated occupational domains (MDODs), where they comprised only 22.1% of characters (n=47), compared to 77.9% of men (n=166).

A similar pattern emerged for textual representation (N=325; Fisher's Exact p <.001, Cramer's V = 0.409). Within female-dominated occupational domains (FDODs), women (n=104) were more frequently represented than men (37.0%, n=61), comprising 63.0% of the total. Within male-dominated occupational domains (MDODs), women comprised only 22.5% (n=36) of the characters, compared to 77.5% male characters (n=124).

For visual representations, the gender differences were even more pronounced (N=135; Fisher's Exact p <.001, Cramer's V = 0.441). Women constituted 65.9% (n=54) of characters in female-dominated occupational domains (FDODs) compared to 34.1% of male characters (n=28), but only 20.8% (n=11) of characters in male-dominated occupational domains (MDODs), where men constituted 79.2% (n=42). Therefore, H2 was fully supported across all data sets.

4.2.3 Hypothesis 3a: In female-dominated occupational domains (HEED and services), men are disproportionately represented in high-level occupational roles, while women are disproportionately represented in low- and medium-level occupational roles

To investigate whether gender distribution across hierarchical levels was disproportionate, we conducted Fisher-Freeman-Halton exact tests on 2 × 3 contingency tables (Gender [Male/Female] × Segregation Level [High/Medium/Low]), stratified by domain type. Significant omnibus tests were followed by pairwise post-hoc Fisher's Exact tests with a Bonferroni-corrected alpha of $p < .017$.

The analysis of the combined dataset for female-dominated occupational domains (FDODs; $N = 242$) revealed a significant overall association between gender and hierarchical level ($p = .001$, Cramer's $V = 0.228$). Post hoc pairwise comparisons showed that this was driven by a significant difference between the medium and low levels (Fisher's Exact Test, $p < .001$). No significant differences were found between the high and medium levels ($p = .776$) or the high and low levels ($p = .175$). At the high level, women comprised 61.5% ($n = 8$) of the characters, and men comprised 38.5% ($n = 5$). At the medium level, women comprised 55.4% ($n = 82$) and men 44.6% ($n = 66$). At the low level, women comprised 79.0% ($n = 64$) and men 21.0% ($n = 17$).

For textual representations ($N = 162$), the overall association between gender and hierarchical level was also significant ($p = .026$, Cramer's $V = 0.209$). Post-hoc pairwise comparisons revealed a significant difference in the gender distribution between the medium and low levels (Fisher's Exact $p = .010$), but not between the high and medium ($p = 1.000$) or high and low levels ($p = .240$). At the high level, women constituted 60.0% ($n = 6$) of the characters, and men constituted 40.0% ($n = 4$). At the medium level, women comprised 56.2% ($n = 59$) and men 43.8% ($n = 46$). At the low level, women comprised 78.7% ($n = 37$) and men 21.3% ($n = 10$).

For image representations ($N = 80$), the overall association between gender and hierarchical level was not statistically significant ($p = .053$, Cramer's $V = 0.265$). Consistent with this, subsequent post-hoc pairwise comparisons found no significant differences between the high and medium levels (Fisher's Exact $p = 1.000$), the high and low levels ($p = .530$), or the medium and low levels ($p = .030$). At the high level, women represented 66.7% ($n = 2$) of the characters, and men represented 33.3% ($n = 1$). At the medium level, women comprised 53.5% ($n = 23$) and men 46.5% ($n = 20$). At the low level, women comprised 79.4% ($n = 27$) and men 20.6% ($n = 7$).

Based on these findings, H3a was only partially supported in the combined and textual data and not supported in the images. For the text data, a significant pattern of vertical segregation was found. However, only the prediction of women's disproportionate representation at low levels was confirmed. The hypotheses for women at medium levels and for men at high levels were not supported by the data.

4.2.4 Hypothesis 3b: In male-dominated occupational domains (STEM and skilled trades), men are disproportionately represented at all occupational levels (Low, medium, and high)

The analysis of the combined dataset for male-dominated occupational domains (MDODs; $N=213$) showed a significant overall association between gender and hierarchical level ($p=.006$, Cramer's $V=0.222$). Post hoc pairwise comparisons indicated that this was driven by a significant difference between the high and low levels (Fisher's Exact Test, $p=.003$). The comparisons between the high and medium levels ($p=.024$) and the medium and low levels ($p=.133$) were not statistically significant. At the high level, men comprised 61.9% ($n=26$) of characters and women 38.1% ($n=16$). At the medium level, men comprised 79.9% ($n=119$) and women 20.1% ($n=30$). At the low level, men comprised 95.5% ($n=21$) and women 4.5% ($n=1$).

For textual representations ($N=160$), the overall association between gender and hierarchical level was also significant ($p=.004$, Cramer's $V=0.254$). The post-hoc comparison between the high and low levels was significant (Fisher's Exact $p=.002$), while the comparisons between the high and medium levels ($p=.052$) and medium and low levels ($p=.041$) were not significant. At the high level, men constituted 62.5% ($n=25$) of characters and women 37.5% ($n=15$). At the medium level, men comprised 79.6% ($n=82$) and women 20.4% ($n=21$). At the low level, men comprised 100.0% ($n=17$) of characters, with no women depicted ($n=0$).

For image representations ($N=53$), no significant overall association was found between gender and hierarchical level ($p=.558$, Cramer's $V=0.143$). Consistent with this, none of the post-hoc pairwise comparisons reached statistical significance: high vs. medium ($p=.377$), high vs. low ($p=1.000$), and medium vs. low ($p=1.000$). At the high level, representation was equal, with one man (50.0%) and one woman (50.0%). At the medium level, men comprised 80.4% ($n=37$) of characters and women 19.6% ($n=9$). At the low level, men comprised 80.0% ($n=4$) and women 20.0% ($n=1$).

The findings also provided only partial support for H3b in the combined and textual data, but not in the visual data. In textual depictions, a significant pattern of vertical segregation was found. However, the hypothesis that men would be disproportionately represented at all three levels was not fully confirmed. The claim was statistically supported only for the low level, where men's representation was highest, but not for the medium or high levels. Therefore, while women descriptively outnumbered men at all levels in the text, the hypothesis of disproportionate overrepresentation was only met at the lowest level.

5 Discussion

This study examined general, horizontal, and vertical occupational gender segregation in textual and visual representations in German occupational orientation textbooks. The results provide evidence that textbooks reinforce traditional gender stereotypes. Three key findings emerged: First, women were generally significantly underrepresented in occupational roles, an effect driven by textual portrayals. Second, strong horizontal segregation was evident across both textual and visual representations,

with women overrepresented in female-dominated occupational domains (FDODs) and men overrepresented in male-dominated occupational domains (MDODs). Our results are comparable to those of the German labor market distributions (Bundesagentur für Arbeit, 2024). For instance, the gender distribution in our sample within FDODs (64% female) and MDODs (22% female) is strikingly similar to workforce statistics. This suggests that the textbooks we investigated function less as tools for expanding possibilities but instead mirror the existing segregation status quo. This occurs despite substantial use of gender-neutral language (38% of all portrayals), indicating that linguistic inclusivity alone (Sczesny et al., 2016) is insufficient to counteract deeply entrenched occupational stereotypes. Third, our analyses revealed that while horizontal segregation is consistently observed across both text and images, vertical segregation occurs only in textual representations. For both FDODs and MDODs, a significant pattern of vertical segregation was observed, with women being overrepresented at lower hierarchical levels in FDODs and men being overrepresented at all hierarchical levels in MDODs.

Our findings regarding the overall underrepresentation of women (H1) and the pronounced horizontal segregation (H2) align with a long history of textbook research that identifies educational materials as carriers of traditional gender roles (Moser, 2016; Ott, 2021). However, our study provides three crucial extensions. First, by systematically employing contemporary occupational classifications (FDOD, including HEED occupations and services, and MDOD, including STEM occupations and skilled trades; Blackburn et al., 2014; Croft et al., 2015; Fayer et al., 2017), our study offers a more comprehensive and current picture than earlier studies that relied on broader, less systematic categories (Finsterwald & Ziegler, 2007; Lindner & Lukesch, 1994; Ott, 2017).

Second, we applied this classification to systematically compare gender occupational segregation across textual and visual representations. This allowed us to investigate not only whether segregation exists in these specific domains but also how it manifests across different modalities. While prior studies have examined both modalities (Strahl et al., 2014), our study also focuses on horizontal and vertical segregation, which yielded an interesting distinction: horizontal gender segregation was comparable across textual and visual representations, whereas the overall underrepresentation of women and the patterns of vertical segregation were primarily observed in textual representations. Our study reveals that different forms of occupational gender stereotypes manifest differently across representational modes; a methodological insight that single-modality studies (Finsterwald & Ziegler, 2007; Kerkhoven et al., 2016; Lee, 2014) cannot capture.

Third, and most critically, our study is the first to investigate gender distributions in specialized career orientation textbooks. While general and horizontal gender segregation has been found in general-subject textbooks ([blinded for review]) and other educational materials (Evans & Davies, 2000; Wharton, 2005), its presence in textbooks with an explicit curricular mandate to broaden students' career horizons (Draaisma et al., 2018; Guichard, 2001; ISB, 2025) is particularly concerning.

Our findings regarding vertical segregation (H3a and H3b) reveal a more nuanced picture than documented in previous textbook research (Finsterwald & Ziegler, 2007; Guichot-Reina & La Torre-Sierra, 2023). They are domain-specific and modality-

dependent, thus challenging simplified approaches to investigating vertical gender segregation in textbook research. We found no significant differences in gender representations across hierarchical levels in visual representations. This modality-specific finding suggests that images may not effectively convey hierarchical relationships without accompanying textual cues and may thus lead to an incomplete understanding. Our analyses of textual representations partially supported our hypothesis for female-dominated domains (H3a) and fully supported our hypothesis for male-dominated domains (H3b).

Within female-dominated occupational domains (FDODs), we did not find evidence for a 'glass escalator' effect, the phenomenon where men in female-typed fields experience accelerated advancement into leadership positions (Williams, 1992, 2013). Instead of the hypothesized overrepresentation of men at the highest hierarchy level, our analysis revealed the opposite finding: a disproportionate concentration of female characters at the lowest hierarchical level, constituting 78.7% of characters at that level. This finding reflects a 'sticky floor' (Berheide, 1992) effect: While textbooks portray women across all levels in these FDODSs, they disproportionately anchor them in entry-level positions. Within male-dominated occupational domains (MDODs), textual representations revealed a systematic male dominance, although not entirely as hypothesized. While men outnumbered women at all three hierarchical levels, the statistically significant pattern was driven by the complete male domination at the lowest level, where no female characters were depicted.

These findings diverge from both our hypotheses and real-world labor market data in meaningful ways. The absence of the predicted glass escalator effect in FDODs contradicts documented distributions where men in female-dominated domains often advance more rapidly than their female colleagues (ILO & World Health Organization, 2022; Puzio & Valshtein, 2022). Similarly, the complete exclusion of women from entry-level positions in MDODs misrepresents the realities of the labor market. Their low representation at the middle and high hierarchy levels may align with previous research (Guichot-Reina & La Torre-Sierra, 2023; Ott, 2017), however, it misrepresents the German situation, where women, especially in technical occupations, show high advancement rates (Vicari et al., 2023). The underrepresentation of female characters in MDODs in occupational orientation textbooks conveys a clear message that technical and skilled trade careers are not suitable for girls; a perception empirically documented among female students by Lindner and Makarova (2024).

The contrasting distribution between domains, with women concentrated at lower levels in FDODs while men completely dominate MDODs, may reflect a form of selective progressiveness by textbook authors and publishers. This creates an illusion of gender equity by showcasing female presence within 'acceptable' feminine domains while maintaining rigid boundaries in masculine domains. Such a portrayal could be more insidious than uniform underrepresentation, as it implicitly teaches students that female ambition is permissible only within traditionally prescribed limits (Sinclair & Carlsson, 2013).

5.1 Theoretical implications

Our findings have important theoretical implications, particularly in relation to Social Role Theory (Eagly & Wood, 2012) and Gottfredson's (2002) theory of career development. Social Role Theory posits that gender stereotypes arise from observing men and women in different social roles. Our results identify career orientation textbooks as a potentially important source of such observations for adolescents. By documenting strong horizontal and vertical segregation, our study demonstrates that these textbooks function as cultural artifacts that contain the very role-based cues that Social Role Theory identifies as foundational to stereotype formation. Furthermore, the modality-dependent nature of our findings, where, for instance, vertical segregation was significant only in text, suggests that these observations may be transmitted with varying intensity across different forms of representation. Building on this, Gottfredson's (2002) theory of Circumscription, Compromise, and Self-Creation provides insight into how the differences in gender representations constrain career development. During adolescence, students progressively eliminate career options perceived as incompatible with their gender identity (Korlat et al., 2022, 2023). Textbooks, like the ones we have investigated in our study, provide the type of information that contributes to this narrowing process. The pervasive gender occupational segregation found in our study may lead to girls forgoing choices and opportunities, irrespective of their actual interest or aptitude. The pervasive horizontal segregation and the contrasting picture of vertical segregation found in our study are particularly relevant here. For young women, the message is complex: the depiction of women at all hierarchical levels within FDODs may initially seem empowering. However, when contrasted with the absolute male dominance shown in MDODs, it may implicitly convey that female career advancement is permissible only within these traditionally feminine boundaries. This can lead to a form of circumscription where girls forgo choices in MDODs, regardless of their actual interests or aptitudes. For young men, the message is more straightforward. The depiction of male dominance across all hierarchical levels of MDODs reinforces the notion that these domains are their natural territory, potentially leading to inflated expectations of advancement (Eagly & Karau, 2002; Weisgram et al., 2011). This dual messaging likely leads to what Gottfredson terms "compromise," where students adjust their career aspirations to match those perceived as gender appropriate. Young women may internalize the message that MDODs are largely closed to them, while young men are encouraged to pursue them with confidence. Such early compromises, shaped by the stereotypical content of educational material, can have lasting effects on career trajectories and economic outcomes (Reskin & Bielby, 2005).

5.2 Practical implications

Our findings have practical implications for educational stakeholders. For educators, the results highlight the need for a critical approach to career orientation materials. Rather than using textbooks solely for the transfer of didactic expertise (Hansen, 2018), teachers can leverage the stereotypical representations we identified as a pedagogical tool. By making these biases an explicit topic of classroom discussion, edu-

cators can foster students' critical media literacy and encourage them to deconstruct gender stereotypes in the professional world (Kostas, 2023; Liu, 2006). Furthermore, teachers should actively supplement the curriculum with materials that provide counter-stereotypical role models to present a more balanced view of career possibilities (Olsson & Martiny, 2018).

For textbook authors and publishers, our study shows a need to develop more equitable materials. Based on our findings, this involves three key actions: (1) ensuring numerical parity of men and women, especially in text; (2) challenging horizontal segregation by including counter-stereotypical role models (e.g., women in STEM, men in HEED; Puzio & Valshtein, 2022); and (3) addressing vertical segregation, e.g., systematically portraying women in leadership positions across all domains. Implementing these changes would help transform textbooks from being passive mirrors of a segregated society to active tools for fostering inclusive career guidance.

5.3 Limitations and future research directions

This study provides insights into horizontal and vertical occupational gender segregation in German occupational orientation textbooks, particularly in relation to female-dominated (i.e., HEED and services) and male-dominated (i.e., STEM and skilled trades) occupational domains. Despite several important findings, several limitations must be considered.

First, we analyzed textbooks exclusively from vocational-oriented schools (*Mittelschule*). While we deliberately selected this track because it places the strongest emphasis on occupational orientation and practical career preparation, with students typically transitioning directly to vocational training or employment after graduation, this focus limits the generalizability of our findings. The occupational portrayals in vocational-track textbooks may emphasize different hierarchical levels than those in academic-track (Gymnasium) textbooks. While the academic track leads toward university education and potentially higher-status careers, the vocational track typically leads to apprenticeships or direct employment. The vocational track textbook might therefore underrepresent high-level positions that require a university education. Furthermore, as our sample is culturally and nationally specific, the findings may not be generalizable to textbooks in other countries with different educational systems and cultural norms regarding gender. Future research should therefore examine career representations across all three German educational pathways and conduct cross-cultural research to gain a better understanding of the generalizability of our findings.

Second, our finding that horizontal segregation is evident in both text and visual representation, while vertical segregation emerges primarily in textual representation, reveals important methodological considerations. This discrepancy likely reflects the inherent challenges of conveying hierarchical status in visual depictions compared to explicit textual titles and descriptions (Stanczak, 2007). Future research should develop more sophisticated visual analysis methods to capture subtle status indicators in textbook images (Good et al., 2010).

Third, our analysis excluded some aspects of Moser et al.'s (2013) coding system, such as activities and gender-fair language usage. The use or non-use of gender-fair language significantly impacts the construction of gender roles (Sczesny et al., 2016)

and occupational perceptions (Vervecken et al., 2015). As an integral component of textbook-related research, future research should examine the full range of different forms of gender-fair language within occupational representations in educational materials.

A fourth limitation is our study's reliance on a binary operationalization of gender. Our methodology was based on the predominantly binary grammatical gender of occupational terms in German. While this binary focus aligns with historical sociological frameworks that treat gender as a structural category for analyzing occupational segregation (Blackburn et al., 2002; Risman, 2004), we acknowledge that it does not capture the full spectrum of gender as understood in contemporary theory (Hyde et al., 2019; Schmader & Nater, 2025). Future research should therefore aim to develop methodologies to identify and analyze non-binary and gender-diverse representations in educational materials. Such work, as discussed in recent work (Cruz Neri et al., 2024; Koster et al., 2025), is crucial for providing a more complete and more inclusive picture of gender in textbooks.

Despite these limitations, this study advances the field by integrating sociological frameworks of horizontal and vertical occupational segregation with contemporary occupational classifications and theoretical perspectives on gender stereotypes within career orientation textbooks. To our knowledge, these research streams have not been systematically combined or investigated in relation to one another previously. Future research should extend its focus to the private and unpaid sphere of gender representations (Coltrane & Adams, 1997; Ferrant et al., 2014) in order to more fully capture the division between private and public/work spheres (Landes, 1995/2013; Pateman, 1983; Wischermann & Mueller, 2004), particularly in the context of gender, work, and social inequality (Jarvis, 2017) as represented in textbook knowledge.

6 Conclusion

This study's systematic examination of textual and visual gender representations in German occupational orientation textbooks reveals a pervasive occupational gender segregation. Across 1,195 portrayals, we found that women were underrepresented overall, overrepresented in female-dominated occupational domains, such as HEED and service occupations, and underrepresented in male-dominated occupational domains at all hierarchy levels. Instead of broadening the potential occupational possibilities for students, the investigated textbooks appear to perpetuate the very stereotypes that limit adolescents' aspirations. However, our findings also provide a constructive perspective for change. Creating equitable resources requires a conscious effort by authors and publishers to avoid stereotypical gender representation in textbooks. This involves, first, achieving numerical parity in the overall representation of men and women in occupational roles in textual and visual representation in textbooks. Second, horizontal segregation in gender representation in occupational roles should be avoided and could even be counteracted by showcasing disproportionately high numbers of counter-stereotypical role models (e.g., women in STEM, men in HEED; Puzio & Valshtein, 2022). Third, vertical segregation can be challenged by portraying women in positions of authority, responsibility, and leadership across all

occupational domains. Only through such systematic transformation can textbooks fulfill their potential to foster truly inclusive career guidance for all students.

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Declarations

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