

RESEARCH REPORT

Gender and Diversity Awareness among STEM-Teachers: Mono Makes the Difference

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Abstract

The discrepancy between the use and understanding of technological artifacts clearly illustrates the need for a contemporary general education in technology. This is seen as a fundamental prerequisite for citizens to be able to act independently, reflectively, and responsibly in a world increasingly shaped by technology. While technological devices and digital applications are used as a matter of course in everyday life, a deeper understanding of how they work is often lacking. This is precisely where the demand for a solid education in technology comes in. Gender and diversity aspects play a particularly important role here, as it is essential to ensure that all students are addressed in a broad and equitable manner. Numerous studies show that there are differences in students' interest in technology and in their career choices. These differences reinforce the need for gender-sensitive and diversity-conscious concepts that do not perpetuate existing inequalities but specifically seek to reduce them. This study therefore examines teachers' attitudes and knowledge of gender and diversity in STEM education. Based on an online survey of N = 511 teachers, it analyses the extent to which gender, subject affiliation, and experience in mono-educational settings reveal differences (ANOVA, t-tests). The aim is to identify potential for further developing teacher training and to provide impetus for gender- and diversity-sensitive technical didactic approaches.

Keywords: *Gender and Technology, STEM, diversity, mono-educational teaching, attitudes and knowledge.*

Introduction

The Austrian Federal Ministry of Education, Science and Research (BMBWF) emphasizes that schools have a special responsibility not only to accept diversity, but also to proactively shape it (BMBWF, 2023). Teachers play a central role in promoting diversity and challenging gender-specific role stereotypes. Through their expertise, attitudes, and teaching

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methods, they have a significant influence on whether traditional gender stereotypes are critically reflected upon or – often unconsciously – reproduced and reinforced.

Education, in its modern sense, can promote the independence and self-determination of every individual person (Raithel et al., 2009), which will become increasingly important in relation to technology. The discrepancy between the use and understanding of technical artifacts (Acatech & Körber-Stiftung, 2021) highlights the urgent need to promote a contemporary general technical education that serves as the foundation for responsible citizens. There is a particular need for action regarding gender and diversity aspects. As studies show there are significant differences between male and female students in terms of their interest in technology and career choices. Gender and diversity in technical education can thus be understood as the exploration of diverse methods, working media, content areas, and teacher-student interactions that aim to address heterogeneous student groups (Goreth & Windelband, 2020). It is therefore imperative that teachers develop an elaborate awareness of gender and diversity.

Theoretical Background

In the scientific debate on gender, different perspectives can be distinguished from one another. The term *science of gender* refers to research into gender-related stereotypes and their effect on individuals (Bartosch & Lembens, 2012). The focus is on the extent to which socially conditioned ideas of masculinity and femininity influence people's behavior, self-perception, and social interactions. In contrast, the focus of the *gender of science* is on how gender relations shape scientific structures, discourses, and research processes (Augustin-Dittmann, 2017). It examines the extent to which certain disciplines are shaped by gender-specific patterns of thought and attributions. Another research perspective is *Women in Science*, which deals with the continuing underrepresentation of women in STEM professions (Augustin-Dittmann & Gotzmann, 2015; Statistisches Bundesamt, 2018). Despite numerous initiatives and support measures, the proportion of women in scientific and technical professions remains significantly lower than that of men, which is often attributed to structural barriers and persistent stereotypical role models.

Gender and diversity in technical subjects at school can be understood as a heterogeneous student group, which unites, for example, different gender groups, students with and without a migration background, or students with or without special education needs (Goreth & Windelband, 2020); here, a major focus is on the area of gender. In recent decades, one approach to teaching has been the separation of boys and girls in mono-educational settings. Gender-homogeneous learning environments open the possibility of acting independently of socially traditional role expectations and trying out alternative forms of gender roles, thereby potentially creating expanded spaces for individual development and self-expression (Graff, 2014). In contrast, *coeducation* is the joint learning of both genders, which long

served as the educational standard but is now increasingly being subjected to differentiated and critical reflection (Stecklina & Spies, 2008).

From the 1950s onwards, little attention was paid to the topic of gender and diversity in the context of technical education, and it was only discussed superficially. From the 1990s onwards, research interest within diversity and gender studies shifted towards gender theory and empiricism, and the pedagogical approach was characterized by efforts to achieve equality (Krüger, 2011; Faulstich-Wieland, 2011; Klinger, 2014). While research on boys and men became increasingly prominent around the turn of the millennium (e.g. Budde, 2005; Helbig, 2010; 2015; Horstkemper, 2000; Pech, 2009; Preuss-Lausitz, 2005), the number of studies on socialization research declined from 2000 onwards, although interest increasingly focused on the results of gender differences in empirical educational research (TIMSS, PISA, IGLU, PIRLS) (Popp, 2011). In recent years, there has been an increasing focus on the education-gender segment in the context of diversity (or heterogeneity) (Faulstich-Wieland, 2011; Klinger, 2014; Krüger, 2011;), and currently, unequal treatment is the predominant topic of discussion in society (e.g., BMBF, 2021; BMBWF, 2021).

Within technical (and scientific) subject didactics research, groups of researchers are showing great interest in school content areas (or topics or subjects) and how they relate to students' interests. Interest in different content areas is reflected in students' self-assessment responses. Gender-specific differences emerge in the scientific/technical context (e.g., Brown, 1993; Goreth et al., 2021; Kosack, 1994; Mammes, 2004; Virtanen et al., 2015).

Technical artifacts and textbooks have also been analyzed and found to be predominantly male-oriented (Colette & Marjolaine, 2017). Furthermore, higher motivation levels have been demonstrated among female students when social and human dimensions are considered in the classroom (Holstermann & Bögeholz, 2007; Marth & Bogner, 2019). Although there have been few studies on gender-specific aspects in technical education to date, those that do exist show that teachers should be more aware of gender-sensitive teaching.

Another broad field of research in the context of gender and diversity is language and interaction processes. Linguistic debates often focus on the correct naming of gender roles or gender-sensitive choices in image examples (Bath, 2015; Pädagogische Hochschule Bern, 2007; Stadt Wien, 2007), which are rarely empirically proven or have insufficient effect sizes (Verweken & Hannover, 2015). Groups of researchers specializing in teaching methodology examine school interaction processes (mostly between students and teachers, e.g., Augustin-Dittmann & Gotzmann, 2015; Faulstich-Wieland, 2004).

It is striking that teachers are severely underrepresented in this area. However, initial empirical findings show that teachers' interest in different subject areas and, therefore, their self-assessed level of knowledge in these areas are strongly gender-specific (Goreth, 2021). The model of professional competence highlights the importance of professional knowledge (Baumert & Kunter, 2013; Voss et al., 2015). However, beliefs/values and motivational

orientations about gender and diversity must also be addressed centrally in general technology education. Krebs (2023) shows that the degree of awareness within diversity and gender competence varies greatly among teachers in teacher training courses. Addressing gender beliefs in the context of technology education can help to promote high-quality teaching, especially in general education. There is currently a lack of empirical studies dealing with teachers' attitudes towards gender and diversity in the field of science and technology.

Method

Research Question & Hypotheses

The aim of this study is to examine whether teachers differ in their knowledge of and attitudes towards gender and diversity in the school context. On the one hand, it looks at whether there are differences between male and female teachers and, on the other hand, whether there are differences between teachers at different school subjects, such as STEM subjects for example technology and design (formerly technical and textile crafts); physics; and mathematics. The aim is also to find out to what extent teachers' experiences in mono-educational education influence their self-assessments around gender and diversity.

The following hypotheses should be tested for specific groups:

While students in individual fields have relatively good knowledge of feminist theories and consider it important to incorporate them into their teaching (Lucas-Palacios et al., 2022), findings from Spanish teacher training students show that gender-specific topics are only moderately integrated into the curriculum and that individuals who have received gender training feel a higher level of self-efficacy in gender education (Miralles-Cardona, 2025). To date, no subject-specific studies have been conducted in the field of STEM teacher training.

Hypothesis 1 therefore examines the question of whether the integration of gender-sensitive teaching into teacher training curricula has an impact on teachers' perceptions and whether they consider themselves better prepared for gender aspects in the teaching profession because of including this topic in their studies.

H1: There is a difference in the perceived preparation for gender-sensitive teaching between teachers who completed their studies some time ago and those who have only recently completed their studies (due to an increase in the topic of gender-sensitive teaching in the curricula).

While studies focus on the proportion of women in STEM professions (e.g., these women are more strongly represented in manual routine tasks within automation/digitalization) (Leitner et al., 2023) or analyze students' motives for choosing STEM professions (Hartmann, 2014), there are also findings on the effects of mono-educational teaching settings. A large meta-analysis shows that (small) differences in mathematics performance and

science performance can be identified (Pahlke et al., 2014). There are currently no studies on whether the focus on mono-educational educational experiences has an impact on teachers' own teaching practices.

Hypothesis 2 examines the extent to which individuals with and without mono-educational teaching experience take gender aspects into account in their teaching.

H2: Teachers who have already had mono-educational teaching experience have a different attitude towards incorporating gender aspects into their teaching than individuals who have not yet had mono-educational teaching experience.

Female teacher training students show higher pedagogical, altruistic, and idealistic motivations, while male teacher training students show higher subject-related motivation. In addition, female students show greater openness, e.g., interest in students' social and cultural diversity (Kammermeier et al., 2025). In the field of physical education, results show that the perceived importance of achieving gender-equitable goals in sport—in the sense of diverse content delivery—is strongly gender-dependent (Hoven, 2018). No comparable empirical data is available for the STEM field.

Hypothesis 3 therefore examines the question of the extent to which the gender of the teacher influences attitudes towards gender-sensitive teaching.

H3: Women and men differ in their attitudes towards gender-sensitive teaching.

Finally, hypothesis 4 will examine the extent to which, in an overall picture, mono-educational educational experiences and STEM-related training have an influence on attitudes towards gender-sensitive teaching.

H4: There are main and interaction effects when examining the above variables in terms of their influence on attitudes towards gender-sensitive teaching.

Survey instrument

Knowledge and attitudes about gender and diversity influence lesson planning towards gender- and diversity-sensitive subject teaching. Knowledge and interest in content areas are gender-dependent (Goreth, 2021). To expand these findings to include gender and diversity aspects, an online questionnaire on attitudes and knowledge about diversity and gender was developed. $N = 511$ teachers from general education schools in Tyrol participated. The Department of Education Tyrol sent the questionnaire to all currently working teachers and a reminder email was also sent out. Double entries cannot exist. While the first part of the questionnaire asks about teaching experience and training paths, the core of the questionnaire covers attitudes and knowledge about gender and diversity as well as experience with and implementation of different teaching methods. In addition, the questionnaire asks about gender and diversity content in training courses and identifies potential for development. The sample was determined as a quantitative online survey via *soscisurvey*. The survey took approximately 15 minutes to complete.

The questionnaire includes a socio-demographic section on education and professional experience, as well as a subject survey and specific subject questions on knowledge and interests (which will not be considered in this article). For the topic of gender and diversity, items were adapted based on Payer & Petritsch (2015) and Hoven (2018), which enables an interdisciplinary analysis.

Structure of the questionnaire:

- Sociodemographic and questions about teaching activities and completed education
- Four-point Likert scale on *gender in general* comprises 5 items (Cronbach's $\alpha = 0.81$), example item: *I believe that the topic of gender is overused.*
- Four-point Likert scale on *gender content in one's own studies*, comprising 5 items (Cronbach's $\alpha = 0.93$), example item: *Through my studies, I have learned to act in a gender-sensitive manner.*
- Questions about the organization of one's own teaching activities
- Final questions on knowledge

For the present article, only a selection of the data from the questionnaire is described here. The data was primarily evaluated using t-tests for independent samples and one- or two-factor analyses of variance (ANOVA) to test the hypotheses. The questionnaire mainly contained four and five-point Likert scales, which were treated as interval scales in the analysis. This allows the calculation of means, standard deviations, and the comparison of groups using t-tests and ANOVA.

The t-tests were used to test mean differences between two independent groups, for example, in the analysis of gender-specific differences. For comparisons of more than two groups, such as age or educational background, one- or two-factor analyses of variance (ANOVA) were performed. The statistical analyses were performed with a significance level of $p < .05$.

Results

The sample has an average age of $M = 45.4$ years ($SD = 10.6$) and is predominantly *female* (68.4%), with a smaller proportion of *males* (30.9%) and *diverse* genders (0.6%). For the statistical analysis of gender differences, individuals who answered "other gender" had to be excluded due to low absolute numbers (3). No statistical conclusions can be drawn from the study data for these individuals. (Figure 1).

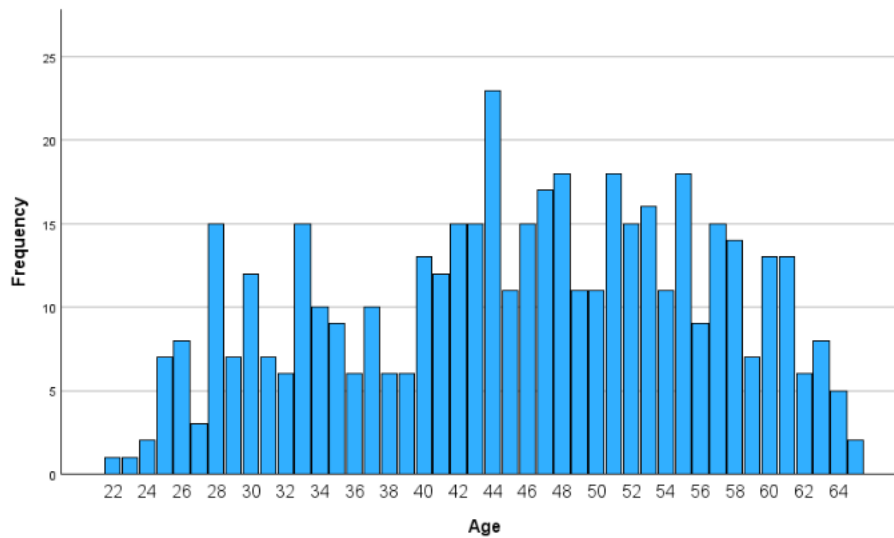


Figure 1. Age distribution of surveyed teachers

There is currently a shortage of teachers in STEM subjects, which compete most strongly with attractive jobs in industry (Brodgelt, 1990; Robinson, 1985). The continuing increase in the shortage of STEM teachers points to a worrying international trend: for example, South Tyrol (Italy) is expected to have a high demand for STEM teachers at secondary level in the coming years (Bildungsdirektion Bozen, 2022), which cannot be met by the current number of graduates. In North Rhine-Westphalia (Germany), only 29% of the demand for chemistry teachers, 17% for physics teachers, and 4% for technology teachers will be met by the 2030/31 school year. All teacher numbers are declining sharply between 2025/26 and 2030/31 (Klemm, 2015, 2021). By 2030/31, there will be a shortage of 2,161 STEM teachers (Klemm, 2021). “In all [German] federal states, the development of demand will be similar to that in North Rhine-Westphalia – albeit to varying degrees – and will be characterized by rising numbers of [students]” (Klemm, 2021, p. 4). In Tyrol (Austria), too, demand and demand trends are currently not being met. For example, in 2020, there was a shortage of 14.9 full-time teaching positions in technical and textile crafts and 12.8 in art education, with demand growing rapidly (in 2027, there will be a shortage of 29.7 full-time teaching positions in technology and design (formerly technical and textile crafts) and 21.0 in art and design (formerly art education) (BMBWF, 2020). The proportion of teachers without specialist training is very high (55% in technology and design), with a sharp upward trend until 2026 (Landesschulrat Tirol, 2016).

By dividing the sample into three age groups (39 years or younger: $n = 132$), middle-aged teachers (40-48 years: $n = 151$), and older teachers (49 years or older: $n = 181$), the results indicate that the composition is changing. Younger teachers are less likely to have studied STEM subjects, while in primary education all subjects are covered in training at a rudimentary level. The composition of the study thus reflects the data from the federal government.

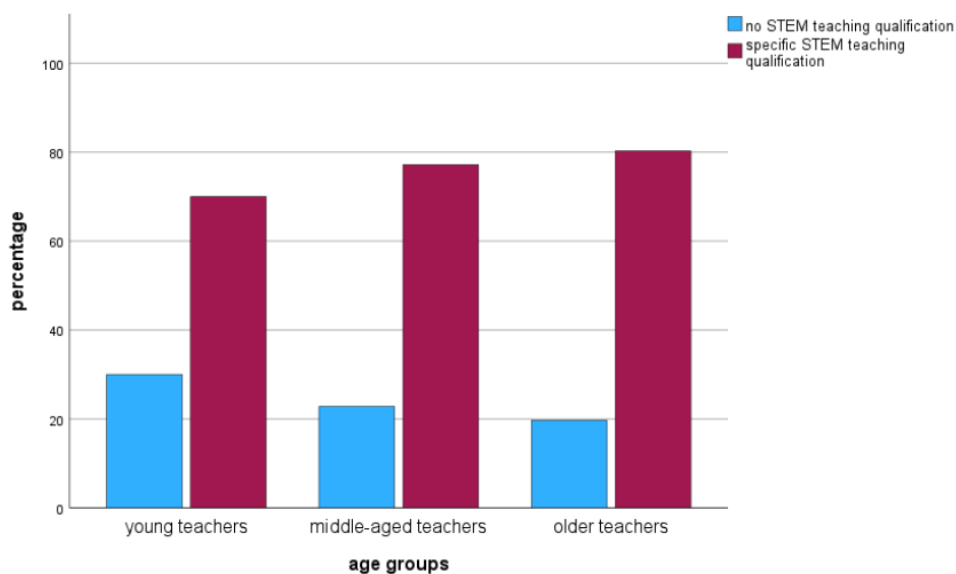


Figure 2. Distribution of subject background (sorted by age group)

If the teachers surveyed had the choice, the majority would prefer to teach *mixed-gender classes* (68.7%), while 27.6% express *no preference* and only 3.7% say they would prefer to teach *mono-educational classes*. *Gender mainstreaming* is the best-known concept among teachers (44.6%), while *reflective coeducation* is the least known (31.2%).

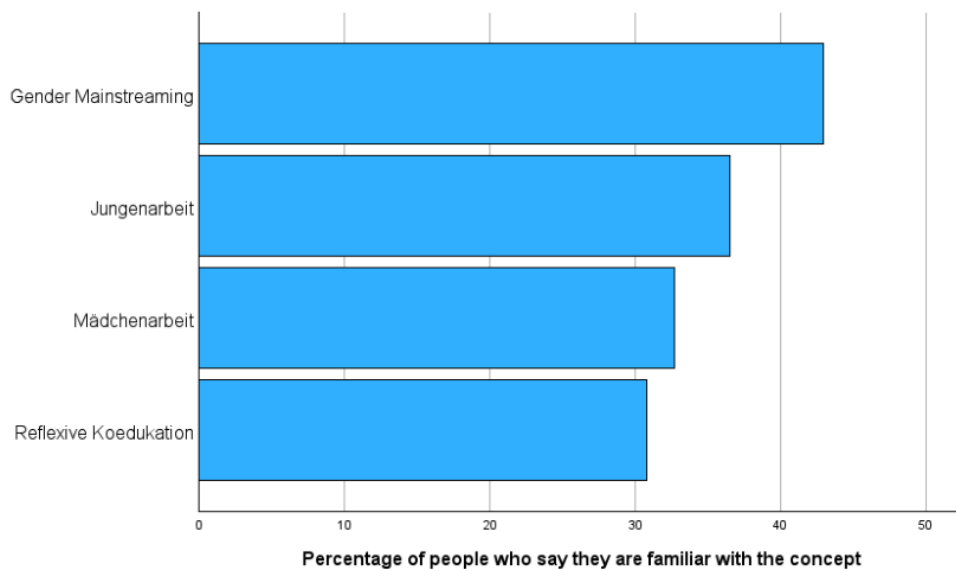


Figure 3. Awareness of different gender concepts

An ANOVA is performed to examine H1. It examines whether the participants in the study, divided into three professional age groups, differ in their assessment of the course in

relation to gender-sensitive teaching. The non-significant Levene's test confirms the homogeneity of variance for the ANOVA.

The age groups (length of service) have a highly significant influence on the assessment of whether gender-sensitive teaching is reflected in the training. A strong effect is observed ($\eta^2 = 0.14$).

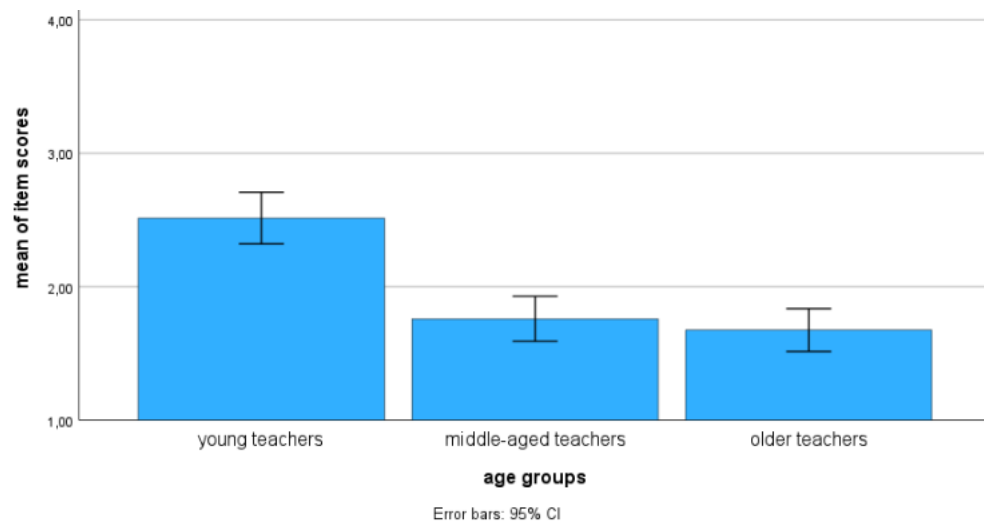


Figure 4. Teacher training contains gender aspects (four-point Likert scale from 1 = “Does not apply at all” to 4 = “Applies”)

On average, individuals from the groups who completed their degree further in the past (see Figure 4) describe that their degree did not focus on gender-sensitive teaching (young teachers: $M = 2.51$, $SD = .82$; middle-aged teachers: $M = 1.76$, $SD = .86$; older teachers: $M = 1.68$, $SD = .89$). Individuals who recently completed their degree describe that their degree did focus on gender-sensitive teaching.

This corresponds with the grades given: young teachers give their training in gender-sensitive content significantly better grades ($M = 2.94$, $SD = .99$) than middle-aged ($M = 3.53$, $SD = 1.17$) and older teachers ($M = 3.70$, $SD = 1.22$).

However, it is apparent that even young teachers tend to make cautiously positive statements about the integration of gender-sensitive teaching. On average, young teachers give their degree a grade of 3 (C) “satisfactory” about the *integration of gender-sensitive teaching*, while the two groups whose studies are further in the past give a grade of only 4 “adequate.” Here, too, the difference between the young and middle-aged groups is highly significant (t-test assuming equal variance tested with Levene's test) with $t(-3.456, 174) < 0.001$ and Cohen's $d = -0.53$.

The next step is to examine the extent to which the changes to the training curricula perceived by young teachers can be further intensified to enhance the perception of these elements in their studies. The aim of including these elements in training curricula should be to promote the desire for further development of practice. As established in the theoretical

section, it can be considered certain that lasting and sustainable change in practice requires a change in teachers' attitudes. In hypothesis 2, therefore, mono-educational education, which was identified as a possible influencing factor in the theoretical section, will be the subject of further analysis.

Mono-educational education experiences could influence attitudes towards gender-sensitive teaching design. In the following, a t-test will therefore be conducted to test the influence of *mono-educational education experiences* on *attitudes towards gender-sensitive teaching design*.

The test will examine whether the group of teachers who have already *taught in mono-educational classes* differs from the group of teachers who have never taught in mono-educational classes. Their statements on the following item will be compared: *“It is important to me to include the gender aspect (of girls and boys) in my teaching.”*

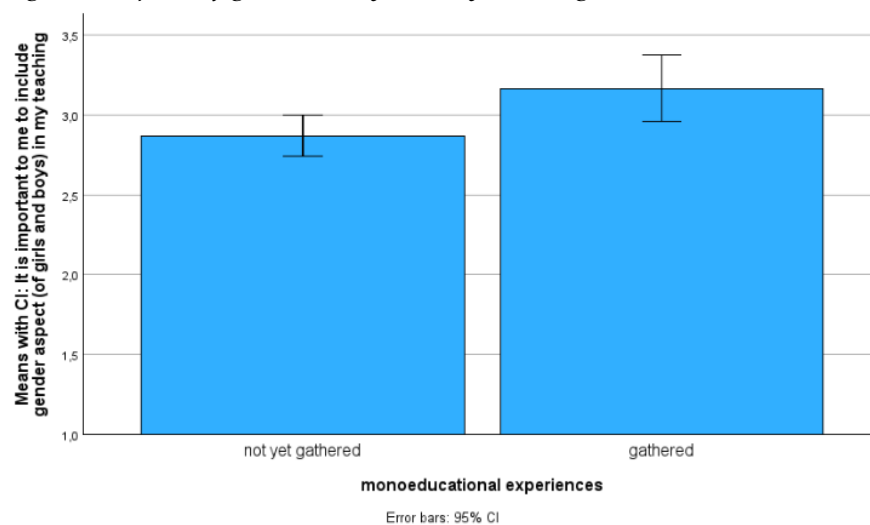


Figure 5. Attitude towards gender-sensitive teaching (four-point scale from 1 = “Does not apply at all” to 4 = “Applies”)

In preparation for the t-test, it is determined that the Levene test is not significant, meaning that the analysis can assume equality of variance (a prerequisite for an unmodified t-test). Teachers who have already taught gender-segregated classes indicate that it is more important to them to incorporate gender aspects into their own teaching ($M_{gender-segregated} = 3.17$; $SD = 0.96$; $M_{not\ gender-segregated} = 2.87$; $SD = 0.97$) with $t(2.83, 298) < 0.01$ and an effect of Cohen's $d = 0.31$.

As explained in the theory section, Statistics Austria data has shown that there is a particularly acute shortage of newly trained teachers in the STEM field, which is also reflected in the present sample. Hypothesis 3 therefore examines the interaction between these factors. For the analysis, a three-factor analysis of variance is now performed in an overall view.

The Levene test is not significant. The analyses therefore assume variance homogeneity. The three-factor ANOVA is significant and yields small main effects for two of the three variables examined, as well as a small interaction effect between the three variables.

The description of the main effect of mono-educational education experiences has already been provided in Hypothesis 2. The following section therefore focuses on the second main effect and the observed interaction effect.

Regarding the second main effect, the correlation derived at the outset is confirmed for the gender variable. Gender has a significant influence on attitudes towards gender-sensitive teaching. Women consider the integration of gender-sensitive aspects into their teaching to be more important than men.

There is a small interaction effect between the three variables examined. This is to be interpreted graphically in a summary of three interaction diagrams. To interpret the interaction effect, descriptive explanations are provided for the diagrams below.

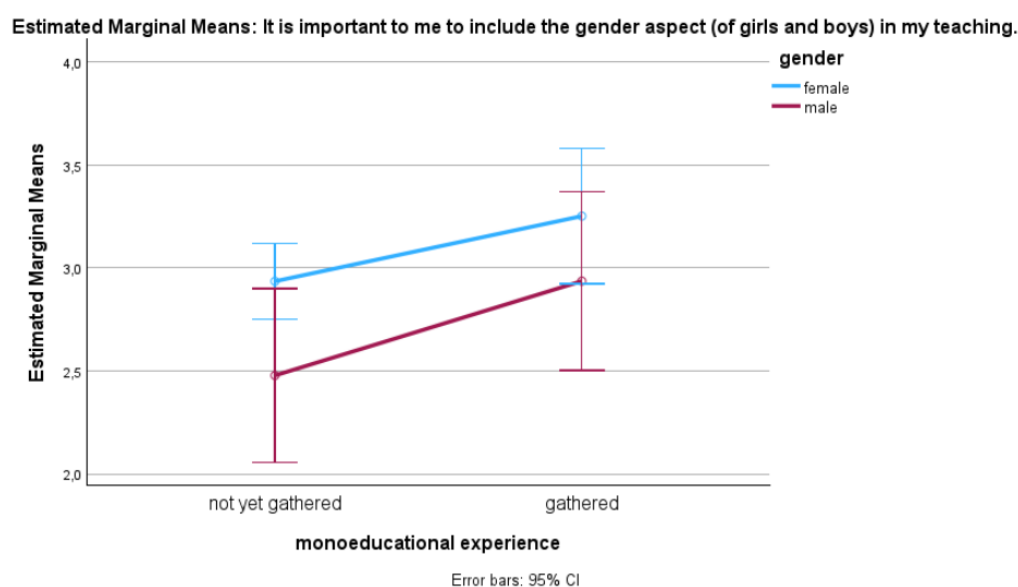


Figure 6. Attitude towards gender-sensitive teaching (four-point Likert scale from 1 = “Does not apply at all” to 4 = “Applies”)

Figure 6 shows the average number of points, including error bars, for the four groups: *females without mono-educational teaching experience, females with mono-educational teaching experience, males without mono-educational teaching experience, and males with mono-educational teaching experience*. Essentially, both main effects can be seen here.

Table 1.

Tests of between-subject effects considering the variables Monoeducational experience, Gender and STEM qualification

Dependent variable: "It is important to me to include the gender aspect (of girls and boys) in my teaching."

Source	Type III Sum of square	df	Means of squares	F	Sig.	partial Eta- square
Corrected model	27.500 ^a	11	2.500	2.871	.002	.129
Constant Term	898.317	1	898.317	1031.516	<.001	.829
Item_monoeducational_experience	4.000	1	4.000	4.593	.033	.021
Gender	3.983	1	3.983	4.573	.034	.021
STEM_qualification	3.546	2	1.773	2.036	.133	.019
Item_monoeducational_experience * Gender	.134	1	.134	.154	.695	.001
Item_monoeducational_experience * STEM_qualification	.219	2	.109	.126	.882	.001
Gender * STEM_qualification	.343	2	.171	.197	.821	.002
Item_monoeducational_ experience * Gender * STEM_qualification	9.548	2	4.774	5.482	.005	.049
Errors	185,495	213	.871			
Total	2232,000	225				
Corrected total variation	212,996	224				

a. R-square = .129 (corrected R-square = .084)

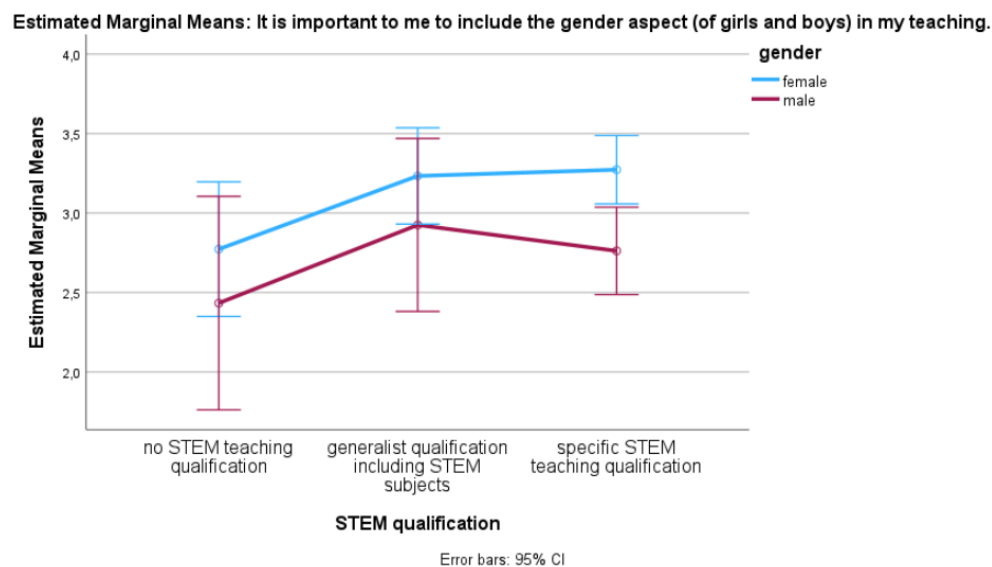


Figure 7. Attitude towards gender-sensitive teaching (four-point Likert scale from 1 = "Does not apply at all" to 4 = "Applies")

Figure 7 shows six groups formed by varying the variables subject with STEM participation and gender. It is interesting to note that, on the one hand, the presence of a STEM subject promotes gender-sensitive teaching, but on the other hand, the differences in the gender of teachers are more pronounced, especially when choosing to study a specific STEM subject. While women with generalist training (especially at the primary level) also value gender-sensitive teaching more than men, this difference seems to become even more pronounced when studying specific STEM subjects.

There are several possible interpretations of the diagram shown above. The educational situation in STEM subjects, in which gender-sensitive teaching methods are clearly anchored in the curriculum, also seems to be emerging among generalist primary school teachers. One possible explanation for the visible increase in differences between male and female teachers could be that children in primary school are largely still being taught before puberty, so that gender-related differences only become more pronounced in secondary school. While female teachers with a specific STEM subject (i.e., secondary school teachers) have a similar attitude to female teachers with a generalist education, this may not be the case for male teachers.

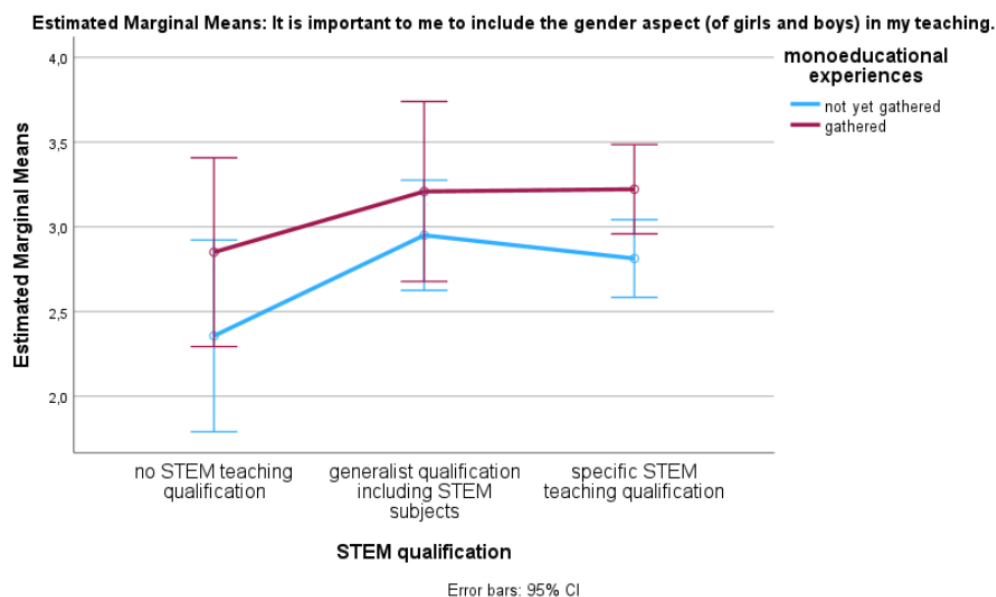


Figure 8. Attitude towards gender-sensitive teaching (four-point scale from 1 = “Does not apply at all” to 4 = “Applies”)

Figure 8 shows that, descriptively, all groups, regardless of whether they are STEM-related or not, benefit from mono-educational educational experiences in terms of their attitudes towards gender-sensitive teaching. More, individuals without a STEM subject benefit most from mono-educational teaching experiences. The overall level among teachers with a STEM background is higher than among teachers without a STEM background.

These findings are consistent with the theoretical assumptions. Since the aspect of gender-sensitive teaching is much more strongly integrated into study curricula and STEM support measures than in non-STEM subjects, non-STEM teachers apparently learn, albeit at a lower level, to reflect on their own practice when they have gained mono-educational teaching experience.

Discussion

It has been shown that young teachers have already had experience with incorporating gender-sensitive content into their training. This observation supports the assumption that curricular reforms are having an effect and that gender-sensitive teaching is not only a formal part of study programs but is also actually being implemented by graduates. Nevertheless, young teachers' assessment of this content is cautious: although they differ significantly from older cohorts who completed their studies before the reforms (especially between the young and middle-aged groups), the average rating of gender-sensitive components in training is only satisfactory. It can be concluded from this that the progress achieved so far is relevant, but not yet sufficient to generate an overall positive assessment of gender-sensitive teaching in teacher training.

Supplementary analyses on the significance of mono-educational teaching experience show that these experiences are associated with a higher attribution of relevance to gender aspects in one's own teaching. Although the effect is small by conventional standards, it points in a significant direction. It is therefore worth discussing whether the targeted integration of mono-educational teaching and learning scenarios into teacher training, for example through teaching and learning laboratories, could contribute to promoting positive attitudes towards gender-sensitive teaching.

Furthermore, the results show that the gender of the teacher has small but measurable effects on attitudes towards gender-sensitive teaching. Of particular interest, however, is the interaction of these variables with the teachers' STEM background, as this has a higher explanatory value. This indicates that measures to further develop gender-sensitive teacher training should not only be general in nature, but also specific in several respects—for example, in terms of subject contexts, the gender of the teacher, and their teaching experience.

The present results should be viewed in light of several limitations. First, the sample is limited to Austria, which means that the findings can only be generalized to other countries to a limited extent. Second, the size of some of the subgroups is small, which limits the statistical power of the analyses and requires cautious interpretation, particularly in the case of interaction effects.

In summary, it can be said that both the gender of the teacher and monoeducational teaching experience have small effects on attitudes towards gender-sensitive teaching. The role of teachers' STEM background is also of particular interest: In

interaction with the other variables, it has greater explanatory value, pointing to the need for targeted and differentiated continuing education and training programs. The findings are not only interesting for the Austrian education sector, as many European education systems focus on coeducation and address the requirements for gender-sensitive teaching. Such programs should not only be designed to be gender-sensitive but also offer the opportunity to address gender-specific aspects within and outside the STEM field. Implications for practice-oriented design could include offering video-recorded self-evaluation in teacher training programs, which contributes to the professionalization of teachers. In addition, teachers could be encouraged to try monoeducational settings in the classroom (e.g., in group work phases during technical experiments).

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