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Teacher collaboration, inclusive education and differentiated instruction: A matter of exchange, co-construction, or synchronization?

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Abstract: Teacher collaboration is considered an important determinant when implementing differentiated instructional practices. However, most research has extensively explored such constructs using global measures, while overlooking the fact that teacher collaboration is a multidimensional construct. Against this background, this study aimed to explore the different teacher collaboration categories (exchange, synchronization and co-construction) and their impact on teachers' differentiated instructional practices. In addition, this study took into consideration important variables for teachers' differentiated instructional implementation, such as self-efficacy, attitudes, and the contextual factor of school track. To respond the research questions, descriptive statistics, one-sample t-tests, mixed analysis of variance with and hierarchical linear regressions were conducted. Results from a mixed analysis of variance indicated that teachers mainly collaborate by means of less demanding and less intensive cooperative practices, such as the exchange of teaching materials and content-related information. Additionally, findings from a hierarchical linear regression indicate that more demanding practices of collaboration, such as synchronization and co-construction, are significantly associated with teachers' differentiated instructional practices. Implications of the results as well as further lines of research are discussed.

Subjects: Teachers & Teacher Education; Educational Research; Inclusion and Special Educational Needs

Keywords: teacher collaboration; inclusive education; differentiated instruction; school type, self-efficacy; attitudes

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1. Introduction

With the ever-growing diversity within the student population, policymakers and researchers urge teachers to embrace diversity by means of differentiated instruction (DI) (UNESCO, 2017). Given that teachers are a determining factor when it comes to the implementation of DI, research has focused on investigating variables that support teachers' instructional behaviors, such as their personal characteristics (attitudes and self-efficacy) (Scarparolo & Subban, 2021). Aside from such characteristics, practical instructional aspects, such as the key variable of teacher collaboration, can also influence teachers' DI implementation (Ghedin & Aquario, 2020). Although teacher collaboration has been widely explored within the inclusive education field, research has ignored the fact that collaboration is a complex and multi-dimensional construct that consists of different tasks (Gräsel et al., 2006; Webs & Holtappels, 2018). As a result, studies have used global constructs and measures to explore how teachers' collaborative work impacts their DI practice.

Against this background, the present study has two aims: first, to explore which category of teacher collaboration teachers mostly perform, and second, to examine whether and to what extent the categories of teacher collaboration influence DI practice. Additionally, this study acknowledges the influential role of teacher-related variables such as attitudes and self-efficacy on teachers' DI practice (Scarparolo & Subban, 2021), and thus includes them within the analyses. The following sections will briefly discuss the current state of the literature on DI and teacher collaboration and will then elaborate on the other important teacher-related variables considered within this study.

2. DI as an Inclusive teaching practice

DI is an inclusive teaching approach that acknowledges student diversity and aims to maximize student learning by carefully aligning the learning environment and tasks according to the individual learning needs of students (Valiandes & Neophytou, 2018). Tomlinson's prominent model (Tomlinson, 2017) provides teachers with a framework on how to address the learning needs of all students by modifying the content, processes, and products, as well as the learning environment and affect, in correspondence to students' readiness, interests, and learning profiles. In this sense, teachers could implement DI through a variety of instructional behaviors such as the use of tiered assignments, homogeneous or heterogeneous subgroups based on students' performance, or the aforementioned readiness or interests (Maulana et al., 2020). Tomlinson (2017) also suggests the use of tutoring systems, staggered nonverbal material such as helping or learning cards, and open education practices such as station-based work, project-based learning, or portfolios. Additionally, research has also pointed at variants of mastery learning strategies such as jigsaw puzzles, enrichments, or prioritized curricula directed at high and low achieving students as effective DI practices (Darnon et al., 2012). In order to effectively implement DI, Tomlinson (2017) emphasizes that teachers should continuously monitor their students' academic process through ongoing assessment (Tomlinson, 2017), which should be tightly linked to their instruction and ensure that all students are provided equally interesting and meaningful tasks and materials (Tomlinson & Strickland, 2005). Moreover, teachers' DI implementation should be paired with other teacher behaviors, such as classroom management, positive classroom climate, and clarity of instruction (Maulana et al., 2020).

3. Teacher collaboration

Collaboration among teachers can play a meaningful role in teachers' instructional behavior (Hartwig & Schwabe, 2018; Mora-Ruano et al., 2018). Within the school context, collaboration can mean that two or more teachers work together with other pedagogical specialists in order to design inclusive learning environments and support students in their personal and social development (Finkelstein et al., 2019).

According to Drossel et al. (2018, p. 188), "collaboration is a complex and multi-layered construct". Therefore, the theoretical conceptualizations of teacher collaboration are manifold (Mora-Ruano et al., 2019). For instance, activity-theoretical studies such as those by Kajamaa and

Lahtinen (2016) identify three categories of collaboration, namely coordination, collaboration, and reflective communication. In contrast, Little (1990) identifies four types of collaborative elements: storytelling and scanning for ideas, aid and assistance, sharing, and joint work. Finally, the seminal work from Gräsel et al. (2006) has been of particular significance within the empirical research context of German-speaking countries (Drossel et al., 2018). Given that this paper addresses the German context, the theoretical framework from Gräsel et al. (2006) will be used to guide this study. Gräsel et al. (2006) model distinguishes between three forms of teacher collaboration:

- (1) Exchange: considered the reciprocal sharing of information; for example, teachers inform each other about professional content and exchange teaching material. This type of teacher collaboration involves teachers working independently from each other without a shared goal.
- (2) Synchronization: referred to as “cooperation based on the division of labour” (Drossel et al., 2018, p. 198). Teachers share a goal and responsibility, while contributing to a common task. According to Webs and Holtappels (2017), this type of division of work increases efficiency.
- (3) Co-construction: entails an intensive form of cooperation in which there is a shared goal, a mutual relating of knowledge, and coordination of teachers’ individual goals with a general common perspective. Drossel et al. (2018) argue that such teacher collaboration has an impact on teachers’ professionalization, improving their teaching practice and teaching quality through constant feedback from and reflection with other teachers (Putnam & Borko, 2000).

Collaboration is highly necessary, as it supports the individual school (e.g., Vangrieken et al., 2015), the students (e.g., Ronfeldt et al., 2015), and teachers themselves, e.g., for their ability to reflect, build new knowledge, or use innovative teaching strategies (Richter & Pant, 2017). However, it should not go unnoticed that more complex and demanding forms of collaboration, such as co-construction, are more infrequently used than, for example, the mere exchange of teaching materials (Richter & Pant, 2016). Additionally, teacher collaboration is associated with challenges such as conflicts concerning ideas regarding the design of teaching and learning processes, concrete agreements and responsibilities in the classroom, the clarity of roles, and the personal compatibility of the cooperation partners (Nel et al., 2014). Hence, teacher collaboration through means of exchange can be considered a “low-cost” and simple form of cooperation in which efforts have a limited impact on teachers (Gräsel et al., 2006).

Research has identified variables that can foster or hinder teacher collaboration (Vangrieken et al., 2015), such as teachers’ background variables (e.g., age and gender) and school tracks. Research in Germany has shown that teacher collaboration has generally been practiced more intensively by younger and female teachers (Mora-Ruano et al., 2018). Moreover, Soltau (2011) found significant differences between female and male teachers among certain forms of collaboration, such as synchronization and co-constructions. Additionally, a study by Maag Merki et al. (2010) revealed that, for women, several aspects of collaboration, exchange of expertise, appear to be more important than they are for their male counterparts.

Since Germany¹ implements a formalized tracking system, differences in collaborative work between teachers in the different school tracks have been investigated. Empirical evidence has reported that, compared to primary schools, teachers collaborate less frequently in secondary schools (Radisch & Steinert, 2005). It appears that teachers within advanced secondary schools collaborate far less, whereas teachers working in comprehensive schools collaborate the most when it comes to lesson preparation (Mora-Ruano et al., 2018). Webs and Holtappels (2018) argue that such differences could be attributed to the resources and implementation difficulties within a particular school track context. However, Mora-Ruano et al. (2018) state that teachers in Germany seldom collaborate.

4. Teacher collaboration and DI

In the context of inclusive education, teacher collaboration has been considered to be an essential quality criterion of inclusive schools (Finkelstein et al., 2019). Studies by Smit and Humpert (2012) and Hartwig and Schwabe (2018) have shown the predictive role of teacher collaboration on teachers' DI practice. Moreover, research has also reported that teacher collaboration is not only relevant for implementing DI (Hartwig & Schwabe, 2018), but also for preparing and reflecting on it (Dixon et al., 2014). By working collaboratively, teachers can reflect on and assess their inclusive teaching practices. Unfortunately, several studies report that teacher collaboration within inclusive classrooms takes place only rarely (Schwab et al., 2015). Important to highlight is that, to the best of our knowledge, only one study has explored the predictive role of the single teacher collaboration forms on DI, indicating that co-construction is a significant determinant of differentiation (Webs & Holtappels, 2018).

5. Other teacher-related variables and DI

While recognizing the importance of teacher collaboration for the implementation of DI, other factors need to be considered. In line with Knauder and Koschmieder (2019), Smit and Humpert (2012), and Letzel (2021), teacher-related variables such as teachers' self-efficacy, attitude, age, gender, and teaching experience are frequently reported. Therefore, it seems meaningful to integrate such teachers-related variables into the present study.

5.1. Self-efficacy and attitudes

Teachers' self-efficacy for inclusion (Savolainen et al., 2020) and their attitudes towards teaching in inclusive settings (Lautenbach & Heyder, 2019) are considered to be two key factors for DI (Letzel et al., 2020). Teachers' self-efficacy is described/defined as the beliefs related to teachers' goals, persistence, and resilience within their profession (Tschannen-Moran et al., 1998). Studies by Suprayogi et al. (2017) and Dixon et al. (2014) have shown a significant positive link between teachers' self-efficacy and DI.

Similarly, previous research has also discussed the important role of teacher attitudes on their inclusive instructional practice (Schwab et al., 2019). According to Haddock and Maio (2014), attitudes are an expression of an individual's own viewpoint of a certain attitude-object and are strongly related to a person's actions. Hence, it is assumed that attitudes play a vital role in teachers' in-class instruction (Baumert & Kunter, 2006). In this sense, "a positive teacher attitude is often perceived as a prerequisite, or catalyst, for inclusive education" (Lautenbach & Heyder, 2019, p. 232). Studies by Hellmich et al. (2019), Yeo et al. (2016), and Schwab et al. (2019) have revealed a strong link between teachers' attitudes and their actual teaching practices. When it comes to the inclusive practice of DI (as in this study), results from Schwab et al. (2019) and Letzel et al. (2020) revealed that teachers holding more positive attitudes tended to differentiate their instruction more.

5.2. Sociodemographic characteristics

Teachers' sociodemographic characteristics, such as age, gender, and teaching experience, have been investigated frequently. Regarding teacher age, empirical research has yielded heterogeneous results. For instance, Tomlinson (2014) has discussed that younger teachers tend to be more differentiated in their instruction. Indeed, a study by Neve de et al. (2015) found a negative correlation between age and DI practice. Nevertheless, after the authors controlled for teacher age in their path analysis, age was found to have a nonsignificant effect on DI use. The same was reported in the studies by Hartwig and Schwabe (2018) and Letzel (2021). Similarly, heterogeneous results can be found for teacher gender and DI practice. Whereas some studies indicate that female teachers tend to differentiate their instruction more (Smit & Humpert, 2012) while males spend less time preparing for DI (Hartwig & Schwabe, 2018), Lindner et al. (2021) did not find significant results of this type. Lastly, amount of teaching experience has also yielded contradictory results. For instance, Lindner et al. (2021) and Wan (2015) have indicated a positive association between teaching experience, whereas Donnell and Gettinger (2015) and Suprayogi

et al. (2017) did not find significant effects. Consequently, the present study will also consider these three sociodemographic variables.

5.3. Purpose and research questions

In light of the aforementioned theoretical background and outcomes of previous studies, the aim of the present study was to use nationally representative large-scale data from the NEPS in Germany in order to investigate how the categories of teacher collaboration are linked to DI practice. The three research questions guiding this study were:

- Which category of teacher collaboration do teachers employ more often?
- To what extent do each of the categories of teacher collaboration vary across school track and gender?
- To what extent do each of the categories of teacher collaboration predict teachers' implementation of DI when controlling for teacher characteristics and school tracks?

Based on the existing research, it was hypothesized that less intensive and demanding forms of collaboration are more often practiced, and that female and/or primary and special education teachers will collaborate more often (Webs & Holtappels, 2018). Finally, it is hypothesized that, together with teaching experience, self-efficacy and attitudes, collaborative work in the form of co-construction are positively associated with teacher implementation of DI practice.

6. Methods

6.1. Sampling and sample

The present study was conducted using nationally representative quantitative data collected in the Starting Cohort 5 (First-Year Students—From Higher Education to the Labour Market) of the NEPS (Blossfeld et al., 2011; NEPS Network, 2023). The sampling process within Cohort 5 was designed to incorporate an oversampling of teacher education students, teacher trainees, and in-service teachers, which were surveyed by means of computer-assisted web interviews (FDZ-LIfBi, 2021). Participation in the NEPS study was voluntary and informed consent was obtained before the start of the survey. The first wave of data collection began in 2010/2011, and up to now, data has been obtained from fifteen measurement points. For the purpose of the study, a cross-sectional analysis of in-service teacher data from wave 14 collected in the fall of 2018 was conducted. The sample consisted of 817 in-service teachers with a mean age of 28.73 years (79% female). The sample was stratified according to school tracks within the German school system: primary school ($N = 26\%$), lower secondary school ($N = 29\%$), advanced secondary school ($N = 32\%$), and special education school ($N = 13\%$). Teachers with missing data were excluded from the study.

6.2. Instruments

6.2.1. Teacher collaboration

In NEPS, teacher collaboration is measured using an adapted and shortened version of the instrument developed by Gräsel et al. (2006), consisting of three subscales: exchange (3 items, e.g., “I communicate with my colleagues about the content of my classes”, $\alpha = .79$; $\omega = .79$), synchronization (3 items, e.g., “Together with colleagues I develop concepts for new teaching programs”, $\alpha = .86$; $\omega = .86$), and co-construction (4 items, e.g., “In order to get feedback, I conduct observed teaching visits with my colleagues”, $\alpha = .60$; $\omega = .60$). All three subscales are based on a 6-point Likert scale ranging from 1 = *never* to 6 = *very often*.

6.2.2. Teachers' self-efficacy and attitudes towards inclusion

In order to measure teachers' self-efficacy and attitudes towards inclusion, NEPS uses an adapted and shortened version of an instrument by Bosse and Spörer (2014). Teacher self-efficacy for inclusion consists of four items (e.g., “I am sure that even with the greatest differences in performance, I can provide appropriate learning opportunities for every child and teenager”, α

= .85; $\omega = .87$). For the case of teachers' attitudes towards inclusion, two subscales were implemented: attitudes towards the arrangement of inclusive education (3 items, e.g., "Joint teaching of children and young people with and without disabilities can meet the needs of all children and young people by appropriate methods", $\alpha = .82$; $\omega = .82$) and attitudes towards the effects of inclusive education (3 items, e.g., "The inclusion of students with disabilities in regular classes can be profitable for students without disabilities", $\alpha = .72$; $\omega = .73$). The three subscales are based on a 6-point Likert scale ranging from 1 = *completely disagree* to 6 = *completely agree*.

6.2.3. Teachers' self-reported DI practice

To measure teachers' self-reported use of DI, an adapted version of the scale "Differentiation" taken from the COACTIV Study (Teachers' Professional Competence, Activating Teaching and Development of Mathematical Competence - *Professionelle Kompetenz von Lehrkräften, kognitiv aktivierender Unterricht und die Entwicklung mathematischer Kompetenz*) by Baumert (2009) was used. It consists of six items (e.g., "I give students homework of varying difficulty depending on their performance level", $\alpha = .84$; $\omega = .85$) based on a 6-point Likert scale ranging from 1 = *never* to 6 = *very often*.

Within the NEPS questionnaire, the participants also answer a series of demographic questions to indicate their gender, age, and the school track in which they are currently working. Additionally, teaching experience concerning students with special needs students is assessed with the item, "Do you have experience teaching students with special needs?", and is based on a 4-point Likert scale ranging from 1 = *very little* to 4 = *very much*.

6.3. Analyses

Analyses were conducted using SPSS 27. First, descriptive statistics of all variables included in the study were calculated as well as one-sample *t*-tests. To answer the first two research questions, a mixed analysis of variance (ANOVA) was used. In line with the theoretical framework proposed by Gräsel et al. (2006), the three categories of teacher collaboration were submitted to a mixed ANOVA as dependent variables, while school track and gender were included as independent variables. With regard to assumption considerations, sphericity was violated and the Greenhouse-Geiser ϵ exceeded .75, thus, the Huyhn-Feldt corrected test statistic, is reported for the within-subject factor and the interaction. For the third research question, a Hierarchical Linear Regression (HLR) analyses was performed. In-service teachers' self-reported DI practice was included as the dependent variable, while age, gender, SEN teaching experience, self-efficacy and attitudes towards inclusion, teacher collaboration categories, and school tracks (as dummy-coded variables) were considered predictors.

7. Results

7.1. Descriptive results

Table 1 shows that the variables of exchange, teacher self-efficacy, both subscales of attitudes towards inclusion (arrangement and effects), and DI practice show a rather high value compared to the theoretical mean of the scales (3.5). In contrast, the variable of co-construction is significantly lower than the theoretical mean of the scale (3.5), whereas the mean score of synchronization indicates a neutral value (theoretical mean of the scale is 3.5).

7.2. Teacher collaboration: differences across school track and gender

The tests of between-subject effects (independent variables) of the mixed ANOVA results reported a significant main effect of school track, $F(3, 741) = 12.54$, $p < .001$, *partial* $\eta^2 = .05$. It appears that primary school and special education teachers more often practice the different collaboration categories in comparison to their counterparts in the other school tracks. No between-subject effects (or interaction effect with school track) was found for gender.

Table 1. Means, standard deviations, and one sample t-tests

	M	SD	df	t	p	Cohen's d
1. Exchange	4.07	.84	816	40.73	<.001	.83
2. Synchronization	3.49	1.26	816	-.17	n.s.	-
3. Co-construction	3.08	.99	816	-12.17	<.001	.99
4. Teachers' self-efficacy for inclusion	3.78	.95	816	8.37	<.001	.96
5. Attitudes towards inclusion: arrangement	3.71	1.14	816	5.31	<.001	1.14
6. Attitudes towards inclusion: effects	3.88	.96	816	11.28	<.001	.96
7. DI practice	3.91	.93	816	12.65	<.001	.93

*Note: M = Mean; SD = Standard deviation; df = Degrees of freedom; t = t value; p = p value.

The tests of within-subject effects (dependent variables) showed significant variations within the three teacher collaboration categories, $F(1.98, 741) = 342.90, p < .001, \text{partial } \eta^2 = .32$. In detail, teachers tend mainly to collaborate by means of exchange, while they rarely carry out collaboration through synchronization and co-construction (Figure 1). Furthermore, a significant interaction effect between teacher collaboration categories and school tracks ($F(5.93, 741) = 9.14, p < .001, \text{partial } \eta^2 = .04$) (Figure 2) was found. Findings indicate that teachers across all school tracks facilitate means of collaboration through exchange. However, in general, advanced secondary teachers use synchronization and co-construction far less than their counterparts in the other school tracks. Additionally, special education teachers, in comparison to the other school track teachers, appear to collaborate through co-construction more often. Furthermore, primary school

Figure 1. Within-subject effects: Differences within the teacher collaboration categories (dependent variables).

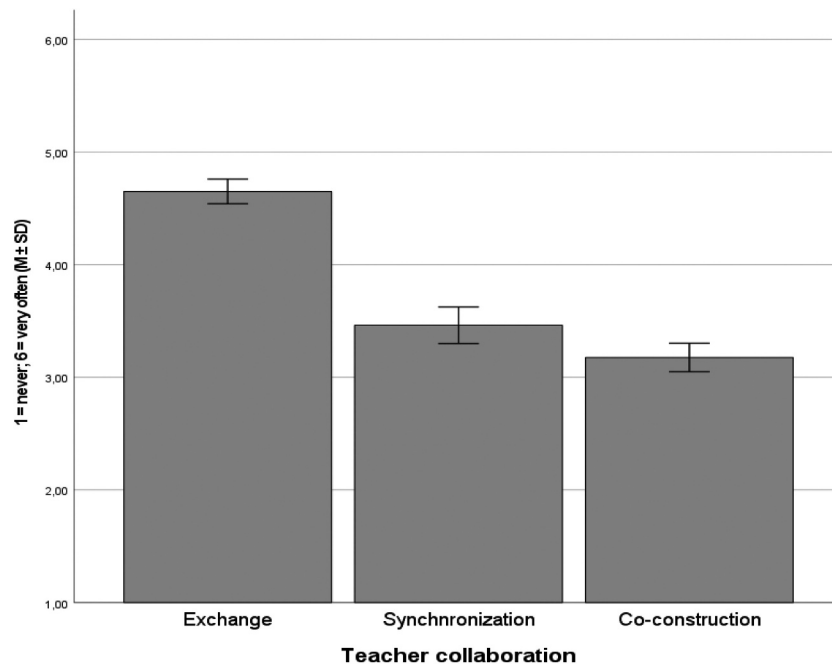


Figure 2. Interaction effect: teacher collaboration categories and school tracks.

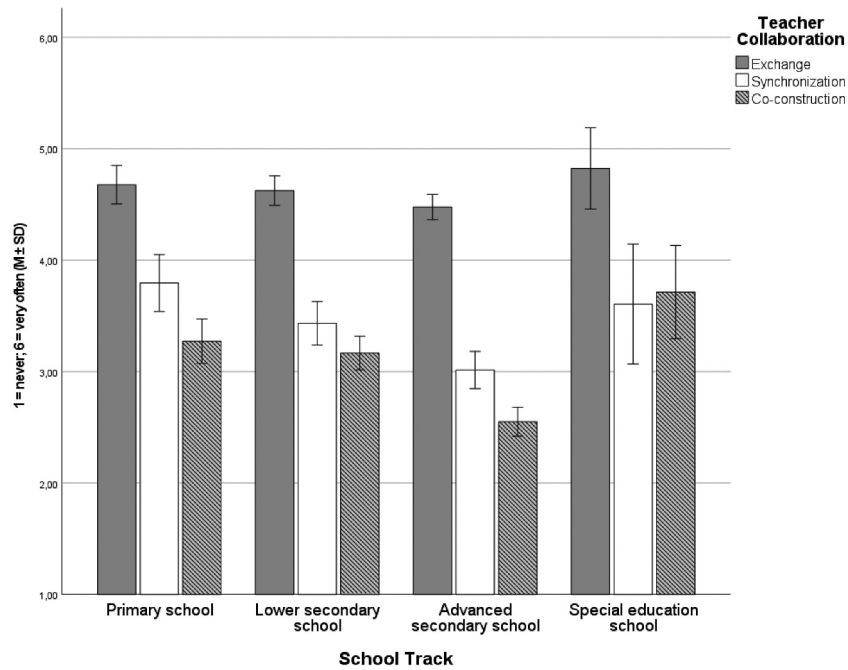
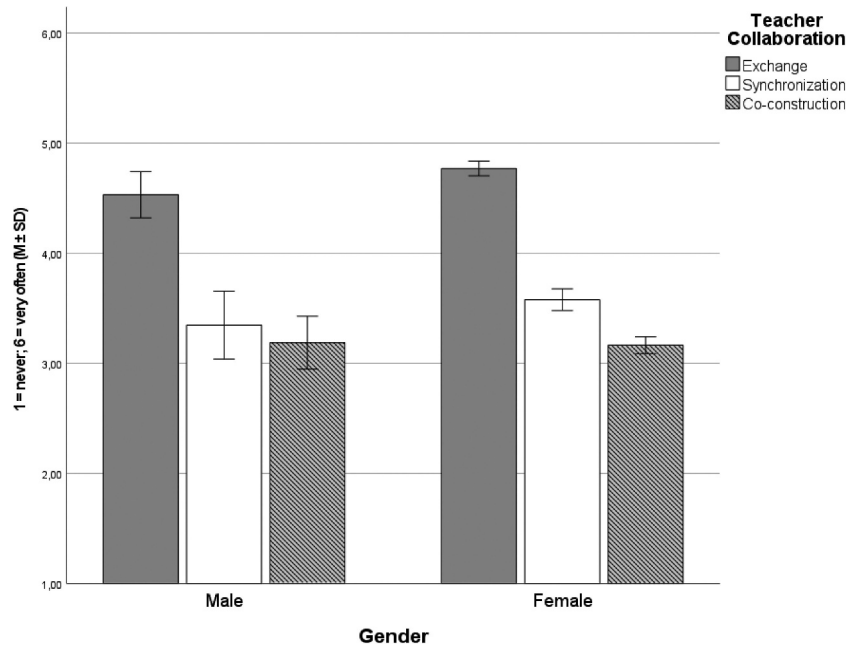


Figure 3. Interaction effect: teacher collaboration categories and gender.



teachers enable synchronization more commonly than the other school track teachers. Lastly, a significant interaction effect between teacher collaboration categories and gender ($F(1.98, 741) = 3.10, p < .05, \text{partial } \eta^2 = .004$) (Figure 3) was also revealed, indicating that female teachers practice collaboration by means of exchange and synchronization more often than male teachers. The analyses did not indicate an interaction effect between teacher collaboration categories, school track, or gender.

7.3. Exploring the predictive role of teacher collaboration

In order to explore the role of teacher collaboration categories in predicting teachers' DI implementation, a four-stage HLR analysis was calculated. The HLR analysis included the subscale of differentiation as the dependent variable. For model 1, the HLR analysis included age, gender, and teaching experience as covariates, while model 2 introduced the predictors of teacher self-efficacy towards inclusion and the two attitudes subscales of arrangements and effects. Model 4 included the three teacher collaboration subscales, and finally, model 4 included school tracks as dummy coded variables. Before the HLR analysis was performed, the independent variables were examined for collinearity.

As seen from Table 2, the HLR analysis revealed that, in model 1, taking gender, age, and teacher experience with SEN students as covariates into the regression equation explained only a significant 17% of the variation in the use of teacher differentiation practice. Introducing self-efficacy and the two attitude scales towards inclusion into the model explained an additional 9.7% of variation in teachers' DI practice, increasing the model's R^2 , significantly, ($F(6,771) = 50.28, p < .001$). When introducing exchange, synchronization, and co-construction (model 3), the variables accounted significantly for 35% of the variation, ($F(9,771) = 45.09, p < .001$). Finally, when the different school tracks were also controlled for (model 4), all variables accounted for 38% of the variance in teachers' DI practice, ($F(12,771) = 38.24, p < .001$). The results indicate that teachers who have more teaching experience with SEN students, perceive themselves as more self-efficacious, have more positive attitudes towards the arrangement of inclusion, collaborate through means of synchronization and co-construction, and teach in primary, lower secondary, or in special education schools tend to implement differentiated instruction more often.

Table 2. Multiple regression models: prediction of teachers' differentiation practice

Variable	Model 1	Model 2	Model 3	Model 4
	β	β	β	β
Age	-.02	-.04	-.02	-.02
Gender*	.06+	.06+	.03	.00
Teacher experience with SEN students	.42**	.28**	.25**	.15**
Teachers' self-efficacy for inclusion		.35**	.31**	.28**
Attitudes towards inclusion: arrangement		.06	.08+	.11*
Attitudes towards inclusion: effects		.03	.03	.06
Exchange			.03	.03
Synchronization			.17**	.15*
Co-construction			.10*	.09*
Primary school*				.17**
Lower secondary school*				.11*
Special education school*				.22**
R^2	.19	.28	.35	.38
ΔR^2	.19**	.10**	.07**	.03**

*Dummy coded for calculations. Gender: 0 = Male, 1 = Female. Reference category for school track: Advanced secondary school. ** $p < .01$; * $p < .05$; + $p < .10$.

8. Discussion

This study tackles the current gap in research and seeks to further contribute by exploring collaborative work among teachers when controlling for teacher self-efficacy, attitudes, socio-demographic variables, and school tracks. The analyses demonstrate that teachers more often practice less demanding, less complex and intensive forms of collaboration; that is, they make use of cooperative work via exchange and rarely exercise co-construction. These results are in line with previous studies in Germany, which found similar differences in the types of collaborative work being done (Harazd & Drossel, 2011; Mora-Ruano et al., 2018; Richter & Pant, 2016; Webs & Holtappels, 2018). Moreover, when observing in detail the descriptive and mixed ANOVA results, it appears that teachers cooperate rather infrequently. Such results are also consistent with prior research that has suggested that the extent of collaboration between teachers in German schools is rather small (Mora-Ruano et al., 2018). Bearing in mind that teacher collaboration has been considered a key factor for school development, teacher professionalization, and instructional practice, it is important to focus on strategies to guide and foster teacher collaboration. Additionally, consistent with previous research, advanced secondary school teachers practice all three types of collaboration less frequently (Gräsel, 2008; Mora-Ruano et al., 2018; Webs & Holtappels, 2018). Furthermore, women collaborate more often than men (Soltau, 2011). Nonetheless, gender showed a significant but rather small effect on the individual collaboration categories. Hence, the findings from this study must be interpreted with caution.

An important finding of the study is that the three forms of teacher collaboration have differentiated effects on teachers' DI practice. Co-construction and especially synchronization positively predict teachers' DI implementation, whereas exchange does not. Although in the present study the predictive role of co-construction is small, it is still aligned with research from Webs and Holtappels (2018), who also reported that this form of teacher collaboration has a positive impact on teachers' development of concepts for differentiation. However, in their study, there was no significant impact of synchronization on teachers' DI activities, but rather on their planning of interdisciplinary curricula. Nevertheless, it is important to highlight that DI does not only refer to aspects of instruction, but also to matters of curriculum planning, which are extremely relevant for effective performance of DI (Hartwig & Schwabe, 2018). Lastly, the HLR analyses confirm the present study's assumptions that synchronization and co-construction contribute significantly to the involved criterion measure even after controlling for other relevant teacher-related variables.

It should not go unnoticed that teachers across all school tracks mainly practice collaboration by means of exchange. However, as seen from the findings, exchange does not have a predictive role on their DI practice. Therefore, the results from the study underline the necessity of increasing teacher collaboration by means of synchronization and co-construction at the school level.

9. Limitations

This study has several limitations. First, the present study is based on cross-sectional results, therefore limiting the causality of the findings. It is strongly suggested that further research follow longitudinal designs that can corroborate the casual direction of the relationships between the variables under study. Furthermore, this study uses teacher self-reports; such responses can be sensitive to overestimation, underestimation, or socially desired answers. Desimone et al. (2010), however, found that teacher self-reports regarding teaching practices are highly correlated to classroom observations. A recommendation for future research is to use a combined research methodology using quantitative (e.g., questionnaires) and qualitative data (e.g., interviews, classroom observations). Teacher interviews in particular could shed light on how teachers collaboratively plan and design differentiated lessons. Another limitation is that the sample consisted mainly of female participants; however, this is representative of the gender distribution across the teaching profession (Stephan et al., 2019). Nevertheless, gender effects should be interpreted carefully. Lastly, previous research has pointed out the need to use appropriate measurement

instruments with regards to teachers' self-efficacy and attitudes DI when exploring the variables impact on the practice of DI (Letzel et al., 2020; Scarparolo & Subban, 2021). Nevertheless, NEPS does not use such domain-specific instruments. Thus, it is strongly suggested that further research include such measurement types within its DI studies.

10. Conclusions

To finalize, the study contributed substantially to research on DI by exploring in detail the relevance of teacher collaboration forms. It was shown especially that the mere exchange of materials and information is not sufficient for DI implementation, but that the division of work, coordination of the work process, connection of results, mutual feedback, and shared responsibility of differentiation are essential for adequate and meaningful DI. In this context, the present study wishes to encourage educational researchers to further explore the multi-dimensional construct of teacher collaboration within inclusive education, as it appears to play a distinctive role in teachers' DI implementation.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

Data availability statement

This paper uses data from the National Educational Panel Study (NEPS; see Blossfeld & Roßbach, 2019). The NEPS is carried out by the Leibniz Institute for Educational Trajectories (LIfBi, Germany) in cooperation with a nationwide network.

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Note

1. For full information on Germany's legislation and education system, please refer to the coordinating body the Standing Conference of the Ministers of Education and Culture (*Kultusministerkonferenz*) (KMK, 2019).

References

- Baumert, J., Blum, W., Brunner, M., Dubberke, T., Jordan, A., & Klusmann, U., et al (2009). *Professionswissen von Lehrkräften, kognitiv aktivierender Mathematikunterricht und die Entwicklung von mathematischer Kompetenz (COACTIV): Dokumentation der Erhebungsinstrumente*. Max-Planck-Institut für Bildungsforschung.
- Baumert, J., & Kunter, M. (2006). Stichwort: Professionelle Kompetenz von Lehrkräften. *Zeitschrift Für Erziehungswissenschaft*, 9(4), 469–520. <https://doi.org/10.1007/s11618-006-0165-2>
- Blossfeld, H.-P., & Roßbach, H.-G., (Eds.). (2019). *Edition ZfE. Education as a lifelong process: The German National Educational Panel Study (NEPS)* (2nd ed). Springer Fachmedien Wiesbaden. <https://doi.org/10.1007/978-3-658-23166-0>
- Blossfeld, H.-P., Roßbach, H. G., & Maurice von, J. (Eds.). (2011). *Zeitschrift für Erziehungswissenschaft: Sonderheft: Vol. 14. Education as a lifelong process: The German National Educational Panel Study (NEPS)*. VS Verlag für Sozialwissenschaften.
- Bosse, S., & Spörer, N. (2014). Erfassung der Einstellung und der Selbstwirksamkeit von Lehramtsstudierenden zum inklusiven Unterricht. *Empirische Sonderpädagogik*, 6(4), 279–299. <https://doi.org/10.25656/01:10019>
- Darnon, C., Buchs, C., & Desbar, D. (2012). The jigsaw technique and self-efficacy of vocational training students: A practice report. *European Journal of Psychology of Education*, 27(3), 439–449. <https://doi.org/10.1007/s10212-011-0091-4>
- Desimone, L. M., Smith, T. M., & Frisvold, D. E. (2010). Survey measures of classroom instruction. *Educational Policy*, 24(2), 267–329. <https://doi.org/10.1177/0895904808330173>
- Dixon, F. A., Yssel, N., McConnell, J. M., & Hardin, T. (2014). Differentiated instruction, professional development, and teacher efficacy. *Journal for the Education of the Gifted*, 37(2), 111–127. <https://doi.org/10.1177/0162353214529042>
- Donnell, L. A., & Gettinger, M. (2015). Elementary school teachers' acceptability of school reform: Contribution of belief congruence, self-efficacy, and professional development. *Teaching and Teacher Education*, 51, 47–57. <https://doi.org/10.1016/j.tate.2015.06.003>
- Drossel, K., Eickelmann, B., van Ophuysen, S., & Bos, W. (2018). Why teachers cooperate: An expectancy-value model of teacher cooperation. *European Journal of Psychology of Education*, 34(1), 187–208. <https://doi.org/10.1007/s10212-018-0368-y>
- FDZ-LIfBi. (2021). *Data manual NEPS starting cohort 5–first-year students, from higher education to the labor market, scientific use file version 15.0.0*. Leibniz Institute for Educational Trajectories.
- Finkelstein, S., Sharma, U., & Furlonger, B. (2019). The inclusive practices of classroom teachers: A scoping review and thematic analysis. *International Journal of Inclusive Education*, 25(6), 735–762. <https://doi.org/10.1080/13603116.2019.1572232>
- Ghedini, E., & Aquario, D. (2020). Collaborative teaching in mainstream schools: Research with general education and support teachers. *International Journal of Whole Schooling*, 16(2), 1–34.
- Gräsel, C. (2008). Die Anregung zur Kooperation im Rahmen von Fortbildungen: unterschiedliche Wege. *Beiträge zur Lehrerbildung*, 26(1), 64–71. <https://doi.org/10.25656/01:13667>

- Gräsel, C., Fußangel, K., & Pröbstel, C. (2006). Lehrkräfte zur Kooperation anregen: eine Aufgabe für Sisyphos? *Zeitschrift für Pädagogik*, 52(2), 205–219. <https://doi.org/10.25656/01:4453>
- Haddock, G., & Maio, G. R. (2014). Einstellungen. In K. Jonas, W. Stroebe, & M. Hewstone (Eds.), *Sozialpsychologie* (pp. 197–229). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-41091-8_6
- Harazd, B., & Drossel, K. (2011). Formen der Lehrerverkennung und ihre schulischen Bedingungen: Empirische Untersuchung zur kollegialen Zusammenarbeit und Schulleitungshandeln. *Empirische Pädagogik*, 25(2), 145–160.
- Hartwig, S. J., & Schwabe, F. (2018). Teacher attitudes and motivation as mediators between teacher training, collaboration, and differentiated instruction. *Journal for Educational Research Online*, 10(1), 100–121. <https://doi.org/10.25656/01:15415>
- Hellmich, F., Löper, M. F., & Görel, G. (2019). The role of primary school teachers' attitudes and self-efficacy beliefs for everyday practices in inclusive classrooms – a study on the verification of the 'Theory of Planned Behaviour'. *Journal of Research in Special Educational Needs*, 19(51), 36–48. <https://doi.org/10.1111/1471-3802.12476>
- Kajamaa, A., & Lahtinen, P. (2016). Carnivalization as a new mode of collaboration. *Journal of Workplace Learning*, 28(4), 188–205. <https://doi.org/10.1108/JWL-11-2015-0084>
- Knauer, H., & Koschmieder, C. (2019). Umsetzung von individueller Förderung in der Praxis der Grundschule: Eine empirisch-quantitative Studie in der Steiermark. In H. Knauer & C.-M. Reisinger (Eds.), *Individuelle Förderung im Unterricht. Empirische Befunde und Hinweise für die Praxis* (pp. 51–68). Waxmann Verlag.
- Lautenbach, F., & Heyder, A. (2019). Changing attitudes to inclusion in preservice teacher education: A systematic review. *Educational Research*, 61(2), 231–253. <https://doi.org/10.1080/00131881.2019.1596035>
- Letzel, V. (2021). *Binnendifferenzierung in der Schulpraxis: Eine quantitative Studie zur Einsatzhäufigkeit und zu Kontextfaktoren der Binnendifferenzierung an Sekundarschulen* [Dissertation]. Universität Trier.
- Letzel, V., Pozas, M., & Schneider, C. (2020). 'It's all about the attitudes!' – Introducing a scale to assess teachers' attitudes towards the practice of differentiated instruction. *International Journal of Inclusive Education*, 6(4), 1–15. <https://doi.org/10.1080/13603116.2020.1862402>
- Lindner, K.-T., Nusser, L., Gehrler, K., & Schwab, S. (2021). Differentiation and grouping practices as a response to heterogeneity – teachers' implementation of inclusive teaching approaches in regular, inclusive and special classrooms. *Frontiers in Psychology*, 12. <https://doi.org/10.3389/fpsyg.2021.676482>
- Little, J. W. (1990). The persistence of privacy: Autonomy and initiative in teachers' professional relations. *Teachers College Record*, 91(4), 509–536. <https://doi.org/10.1177/016146819009100403>
- Maag Merki, K., Kunz, A., Werner, S., & Luder, R. (2010). *Professionelle Zusammenarbeit in Schulen: Schlussbericht*. Universität Zürich, Zürich.
- Maulana, R., Smale-Jacobse, A., Helms-Lorenz, M., Chun, S., & Lee, O. (2020). Measuring differentiated instruction in the Netherlands and South Korea: Factor structure equivalence, correlates, and complexity level. *European Journal of Psychology of Education*, 35(4), 881–909. <https://doi.org/10.1007/s10212-019-00446-4>
- Mora-Ruano, J. G., Gebhardt, M., & Wittmann, E. (2018). Teacher collaboration in German schools: Do gender and school type influence the frequency of collaboration among teachers? *Frontiers in Education*, 3. <https://doi.org/10.3389/feeduc.2018.00055>
- Mora-Ruano, J. G., Heine, J.-H., & Gebhardt, M. (2019). Does teacher collaboration improve student achievement? Analysis of the German PISA 2012 sample. *Frontiers in Education*, 4. <https://doi.org/10.3389/feeduc.2019.00085>
- Nel, M., Engelbrecht, P., Nel, N., & Tlale, D. (2014). South African teachers' views of collaboration within an inclusive education system. *International Journal of Inclusive Education*, 18(9), 903–917. <https://doi.org/10.1080/13603116.2013.858779>
- NEPS Network. (2023). *National Educational Panel Study, Scientific Use File of Starting Cohort First-Year Students*. Leibniz Institute for Educational Trajectories (LifBi), Bamberg. <https://doi.org/10.5157/NEPS:SC5:18.0.0>
- Neve de, D., Devos, G., & Tuytens, M. (2015). The importance of job resources and self-efficacy for beginning teachers' professional learning in differentiated instruction. *Teaching and Teacher Education*, 47, 30–41. <https://doi.org/10.1016/j.tate.2014.12.003>
- Putnam, R. T., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning. *Educational Researcher*, 29(1), 4–15. <https://doi.org/10.3102/0013189X029001004>
- Radisch, F., & Steinert, B. (2005). Schulische Rahmenbedingungen im internationalen Vergleich. In W. Bos, E.-M. Lankes, M. Prenzel, K. Schwippert, R. Valtin, & G. Walther (Eds.), *IGLU. Vertiefende Analysen zu Leseverständnis, Rahmenbedingungen und Zusatzstudien* (pp. 159–186). Waxmann.
- Richter, D., & Pant, H. A. (2016). *Lehrerverkennung in Deutschland: Eine Studie zu kooperativen Arbeitsbeziehungen bei Lehrkräften der Sekundarstufe I*. Bertelsmann Stiftung.
- Richter, D., & Pant, H. A. (2017). *Lehrerverkennung in Deutschland: Eine Studie zu kooperativen Arbeitsbeziehungen bei Lehrkräften der Sekundarstufe I (aktualisierte Auflage)*. Bertelsmann Stiftung.
- Ronfeldt, M., Owens Farmer, S., McQueen, K., & Grissom, J. A. (2015). Teacher collaboration in instructional teams and student achievement. *American Educational Research Journal*, 52(3), 475–514. <https://doi.org/10.3102/0002831215585562>
- Savolainen, H., Malinen, O.-P., & Schwab, S. (2020). Teacher efficacy predicts teachers' attitudes towards inclusion – a longitudinal cross-lagged analysis. *International Journal of Inclusive Education*, 26(9), 958–972. <https://doi.org/10.1080/13603116.2020.1752826>
- Scarpaloro, G., & Subban, P. (2021). A systematic review of pre-service teachers' self-efficacy beliefs for differentiated instruction. *Teachers & Teaching: Theory & Practice*, 27(8), 753–766. <https://doi.org/10.1080/13540602.2021.2007371>
- Schwab, S., Holzinger, A., Krammer, M., Gebhardt, M., & Hessels, M. (2015). Teaching practices and beliefs about inclusion of general and special needs teachers in Austria. *A Contemporary Journal*, 13, 237–254.
- Schwab, S., Sharma, U., & Hoffmann, L. (2019). How inclusive are the teaching practices of my German, Maths and English teachers? – psychometric properties of a newly developed scale to assess personalisation and differentiation in teaching practices. *International Journal of Inclusive Education*, 26(1), 61–76. <https://doi.org/10.1080/13603116.2019.1629121>

- Smit, R., & Humpert, W. (2012). Differentiated instruction in small schools. *Teaching and Teacher Education*, 28(8), 1152–1162. <https://doi.org/10.1016/j.tate.2012.07.003>
- Soltau, A. (2011). *Isolation aus Unsicherheit? Berufliche Unsicherheit und deren Zusammenhang zur Lehrerkoooperation* [Dissertation]. Universität Bremen.
- Stephan, M., Markus, S., & Gläser-Zikuda, M. (2019). Students' achievement emotions and online learning in teacher education. *Frontiers in Education*, 1(4). <https://doi.org/10.3389/educ.2019.00109>
- Suprayogi, M. N., Valcke, M., & Godwin, R. (2017). Teachers and their implementation of differentiated instruction in the classroom. *Teaching & Teacher Education*, 67, 291–301. <https://doi.org/10.1016/j.tate.2017.06.020>
- Tomlinson, C. A. (2014). *The differentiated classroom: Responding to the needs of all learners* (2nd ed.). ASCD.
- Tomlinson, C. A. (2017). *How to Differentiate Instruction in Academically Diverse Classrooms* (3rd ed.). ASCD.
- Tomlinson, C. A., & Strickland, C. A. (2005). *Differentiation in practice: A resource guide for differentiating curriculum, grades 9-12*. ASCD.
- Tschannen-Moran, M., Hoy, A. W., & Hoy, W. K. (1998). Teacher efficacy: Its meaning and measure. *Review of Educational Research*, 68(2), 202–248. <https://doi.org/10.3102/00346543068002202>
- UNESCO. (2017). *A Guide for Ensuring Inclusion and Equity in Education*. Retrieved April 7, 2022, from <https://unesdoc.unesco.org/ark:/48223/pf0000248254>.
- Valiandes, S., & Neophytou, L. (2018). Teachers' professional development for differentiated instruction in mixed-ability classrooms: Investigating the impact of a development program on teachers' professional learning and on students' achievement. *Teacher Development*, 22(1), 123–138. <https://doi.org/10.1080/13664530.2017.1338196>
- Vangrieken, K., Dochy, F., Raes, E., & Kyndt, E. (2015). Teacher collaboration: A systematic review. *Educational Research Review*, 15, 17–40. <https://doi.org/10.1016/j.edurev.2015.04.002>
- Wan, S. (2015). Differentiated instruction: Hong Kong prospective teachers' teaching efficacy and beliefs. *Teachers & Teaching: Theory & Practice*, 22(2), 148–176. <https://doi.org/10.1080/13540602.2015.1055435>
- Webs, T., & Holtappels, H. G. (2018). School conditions of different forms of teacher collaboration and their effects on instructional development in schools facing challenging circumstances. *Journal of Professional Capital & Community*, 3(1), 39–58. <https://doi.org/10.1108/JPC-03-2017-0006>
- Yeo, L. S., Chong, W. H., Neihart, M. F., & Huan, V. S. (2016). Teachers' experience with inclusive education in Singapore. *Asia Pacific Journal of Education*, 36(1), 69–83. <https://doi.org/10.1080/02188791.2014.934781>