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Teacher Collaboration and Professional Learning

Examining Professional Development During a National Education Reform

Abstract: Teacher collaboration is an important feature of job satisfaction and self-efficacy for teachers. Moreover, the collaboration of teachers is important for adopting professional changes as professional development (PD) activities that include opportunities for collaboration have been shown to support teachers in improving classroom practice. This may even lead to higher student performance. Situated in the context of the Advanced Placement (AP) reform in the United States, we investigated the perceived importance of opportunities to collaborate with colleagues as a rationale to participate in PD (N = 3,725 teachers). The opportunity to collaborate with colleagues was a primary rationale why teachers selected PD activities. While this rationale is only slightly related to school and teacher characteristics, it was related to PD characteristics. Specifically, opportunities to collaborate with colleagues were important to teachers in selecting informal face-to-face (FtF) PD activities. We conclude that collaborative structures benefit all forms of teacher professional development.

Keywords: Teacher Collaboration, Teacher Professional Development, Social Contact

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Collaboration is a cornerstone in school and instructional development (Meyer, Hartung-Beck, Gronostaj, Krüger & Richter, 2022; Vangrieken, Dochy, Raes & Kyndt, 2015). Teachers who collaborate in teams can collectively identify their school's needs for improvement and adapt their professional practices appropriately (Meyer et al., 2022). One way for teachers to collaborate is to jointly participate in professional development (PD) activities. Recent studies have identified multiple rationales for why teachers participate in PD, with social contact being a primary reason for selecting specific PD activities (e. g., D. Richter, Kleinknecht & Gröschner, 2019; Rzejak et al., 2014). Whereas previous findings generally suggest that teachers' motivation to participate in PD are related to variables at the school, teacher, and PD levels, there is no systematic evidence yet on the extent to which 'social contact' is a criterion for teachers' PD selection (Zhang et al., 2021). Insights into such relationships are important, for instance, to promote the motivation of teachers to advance their professional learning.

This study addresses this research gap by examining the importance of social contacts as a rationale for teachers' PD participation and linking the importance of social contacts to variables at the school, teacher, and PD participation patterns.

Theoretical Background

Teacher Collaboration and Teachers' Professional Learning

Collaboration of teachers can be defined "as joint interaction in the group in all activities that are needed to perform a shared task" (Vangrieken et al., 2015, p. 23) and is crucial for continuous school improvement as it contributes to teachers' professional learning (Darling-Hammond, Hyler & Gardner, 2017; Meyer et al., 2022). In this way, collaboration helps to improve teachers' beliefs and motivation (Lee, Zhang & Yin, 2011; Voelkel & Chrispeels, 2017). Collaboration of teachers is associated with higher instructional quality, which, in turn, enhances students' performance (Goddard, Goddard & Tschannen-Moran, 2007; Vangrieken et al., 2015), and teacher job satisfaction (e.g., Sims, 2017; Toropova, Myrberg & Johansson, 2021).

Collaborative communities of teachers that are usually referred to as Professional Learning Communities (PLC) provide a context for teachers' professional learning (DuFour & Eaker, 1998; Hord, 1997). These communities consist of teachers who share the same vision for their instructional work and student learning (De Neve & Devos, 2017). They allow teachers to jointly discuss problems, share ideas, exchange instructional material, and help teachers to improve their professional practices, which contributes to students' learning (Admiraal, Schenke, De Jong, Emmelot & Sligte, 2021; Stoll, Bolam, McMahon, Wallace & Thomas, 2006; Vangrieken et al., 2015).

Typically, teacher collaboration in schools is more likely to flourish if specific needs are met, like smaller groups, so that teachers are not isolated in their workplace (De Neve & Devos, 2017; Haiyan & Allan, 2021). Anonymity among the teaching faculty due to large school sizes, on the other hand, might hinder the collaborative work of teachers (Leonard, 2002). If teachers are isolated in their schools, they can seek informational and emotional support in online teacher communities (Hur & Brush, 2009; Moudgalya & Staudt Willet, 2019). Moreover, teachers are more likely to collaborate if they expect success from the joint work, i.e., if they perceive themselves and their colleagues as efficacious and likely to collectively reach their goals (Meyer, Richter, & Hartung-Beck, 2020; Vangrieken et al., 2015).

PD activities provide an appropriate context for teacher collaboration as teachers' professional learning is embedded in social and cultural contexts (e.g., Borko, Jacobs & Koellner, 2010; Vangrieken, Grosemans, Dochy & Kyndt, 2017). Like school-based teacher communities, teachers can use PD activities to connect with their peers to collectively reflect on established practices, identify needs for individual improvement, learn from each other's experiences (e.g., Butler, Lauscher, Jarvis-Selinger & Beckingham, 2004; Nordgren, Kristiansson, Liljekvist & Bergh, 2021; Sprott, 2019).

Teacher collaboration in PD activities can be *formal* or *informal* as well as *face-to-face* or *online-based* (Dede, Eisenkraft, Frumin & Hartley, 2016; Sancar, Atal & Deryakulu, 2021). In terms of *formal types of PD activities,* Darling-Hammond et al. (2017) summarized that collaboration is a powerful tool in traditional face-to-face PD as it allows for peer observation and mutual feedback (Garet, Porter, Desimone, Birman & Yoon, 2001). This makes teachers more likely to translate acquired knowledge and skills into instructional practice (Borko et al., 2010; Desimone, 2009). Findings from Penner-Williams, Díaz & Gonzales Worthen (2017) suggest that teacher communities established in a two-year long PD program help teachers' to collectively reflect on their instructional practices. Similarly, Gast, Schildkamp & van der Veen, (2017) found that team-based face-to-face PD is associated with an increase in teachers' pedagogical knowledge and changes of their professional practice.

In online-based PD, however, there is no physical proximity of teachers that would allow face-to-face collaborative work of teachers. Yet, online PD can initiate collaboration of teachers if course designs incorporate prompts that specifically initiate social interactions (e.g., the task to provide feedback in formal online forums; Yoon et al., 2020). Based on their literature review, Dille and Røkenes (2021) showed that teachers use online PD to encourage and inspire their peers, help each other, discuss problems, give insights, and share experience. Buttimer, Littenberg-Tobias & Reich (2022) found that teachers perceive online forums useful for providing elaborated feedback to one another.

Regarding *informal types of PD,* teachers can engage in school-based or online communities to have informal conversations, seek informational and emotional support, and share information or instructional material (De Jong, Meirink & Admiraal, 2019; Hur & Brush, 2009). Informal professional learning in teacher communities helps teachers to reflect their beliefs, knowledge, and instructional practices (Carpenter, Morrison, Craft & Lee, 2020; Fischer, Fishman & Schoenebeck, 2019; Voelkel & Chrispeels, 2017), and ultimately to improve student learning (Fishman et al., 2014; Frumin et al., 2018). In terms of school-based informal learning of teachers, Admiraal et al. (2021) found that the implementation of teacher teams supports a de-privatization of instructional practices as teachers begin to regularly conduct mutual class observations. In this way, teachers can learn from their peers' instructional methods and discuss innovative approaches. In their systematic review, Doğan and Adams (2018) point out that teacher communities are associated with improved professional practices of teachers and, in turn, with students' achievement.

Informal professional learning can also take place in online-based teacher communities. As online communities provide a space for teachers to interact, they can help teachers to find new ideas for their instruction (Fishman et al., 2014; Moudgalya & Staudt Willet, 2019; Rosenberg, Greenhalgh, Wolf & Koehler, 2017). Research on teachers' activities on social media shows that teachers use online platforms, such as Twitter, Instagram, and Facebook, to extend their professional network beyond the boundaries of their school to collaborate with other educators (e.g., Aguilar et al., 2021; E. Richter et al., 2022; Krutka, Carpenter & Trust, 2017). For instance, teachers can use specific

hashtags on Twitter such as #EdChat or #APBioChat, as well as groups on Facebook to build, maintain, and strengthen ties with other teachers (Fischer et al., 2019; Rosenberg et al., 2017, 2020). This helps teachers to seek and provide relevant information for their instruction, especially in the context of changing educational landscapes, and to receive social support from their peers (e.g., Fütterer et al., 2021; Rosenberg, Borchers, Dyer, Anderson & Fischer, 2021; Trust, Krutka & Carpenter, 2016).

Social Contact as a Rationale for PD Participation

Teacher PD is traditionally viewed "as a teaching process/activity focusing on increasing teacher learning and changing teacher classroom practices to improve student outcomes" (Sancar et al., 2021, p. 4). PD activities are suitable to provide teachers with opportunities to collaborate (Kwakman, 2003), and thus, offer space for social contact. Seeking social contacts has long been identified as driving motive for adults to participate in continuing education (e.g., Boshier & Riddell, 1978). However, there is little research that addresses the question whether the opportunity for social contact is also a driving force for teachers' participation in PD, whether it is equally important for all teachers, and whether the importance differs across different kinds of PD.

Previous studies on teachers' participation in PD activities point to a variety of reasons for selecting a specific PD activity (for an overview see Krille, 2020). Among other, including personal interest, external expectation, or career advancement (Kao, Wu & Tsai, 2011; D. Richter et al., 2019; Rzejak et al., 2014), social contact was identified as an important reason across multiple studies (D. Richter et al., 2019; Rzejak et al., 2014; Hauk et al., 2022) and for selecting formal face-to-face as well as formal online PD (Kao et al., 2011) or informal learning environments (Park, Steve Oliver, Star Johnson, Graham & Oppong, 2007). Durksen, Klassen & Daniels (2017) found that among six different reasons, such as gaining expertise or learning more about children, so-called community building was the only motive that predicted teachers' engagement in an informal face-to-face PD. This finding is in line with findings from Bigsby and Firestone (2017) who showed that teachers who have participated in a high-quality learning group in a school seek more collegial interaction. Carpenter and Krutka (2014) identified building networks with peers and collaborating with other teachers as the two main reasons for being active on Twitter. This is largely consistent with findings on other social media platforms (e.g., Instagram, see Carpenter et al., 2020).

As for the school level, empirical research is scarce. School characteristics such as size or school climate have not been systematically examined in their association with PD participation. However, research showed that school characteristics such as schools' overall competitiveness, funding and neighborhood are associated with aspects of instructional quality and student learning outcomes, which in turn could influence teachers' needs and motivations for PD (e.g., Sass, Hannaway, Xu, Figlio & Feng, 2012). D. Richter and Schellenbach-Zell (2016) report that teachers from vocational

schools emphasize 'social contact' as reason for participation more than teachers who work at general-track schools. Krille (2020) and D. Richter et al. (2019) however found no relationship between school type and motives to participate in PD.

On the individual level, Durksen et al. (2017) found that teachers with higher self-efficacy reported higher agreement with the idea of 'building a community' when it comes to collaborative activities (see also Kao et al., 2011). Moreover, Rzejak et al. (2014) also found a positive relationship between learning goal orientation and social interaction as motive for PD engagement. Sociodemographic characteristics, however, play a minor role in this context.

Finally, the extent to which the characteristics of the PD activity itself are related to teachers' reasons to attend PD remains almost unexplored. The evidence on teachers' PD behavior suggests that teachers participate differently depending on the characteristics of the PD activity (e.g., time or content) and that there may be correspondingly different rationales for doing so (Johannmeyer & Cramer, 2021; E. Richter, Marx, Huang & D. Richter, 2020). However, there is no evidence yet on teachers' rationales for choosing face-to-face versus online PD or formal versus informal types of PD.

Research Questions

This study intends to answer the following two research questions (RQs):

(RQ1) How important are opportunities for collaborations with colleagues for teacher selection of PD activities?

(RQ2) What school, teacher, and PD characteristics are associated with teachers' social motivation to participate in PD?

Methods

Study Setting and Sample

This study is connected to a large U.S. National Science Foundation funded project that examines the role of teacher PD during the Advanced Placement (AP) reform in the sciences (e.g., Hübner, Fischer, Fishman, Lawrenz & Eisenkraft, 2021). The AP program is a national program enrolling more than 2.5 million high school students and provides the opportunity to engage in introductory college level content (The College Board, 2020), conceptually similar to 'Leistungskurse' in the German school system. Notably, AP courses are often viewed as high stakes for students as they are acknowledged in competitive college application and often count as college credit allowing students to skip their introductory college courses (e.g., Fischer et al., 2021). Overall, AP program participation scores correlate with student success in college including higher first-year

college GPA, higher graduation rate, and shorter time-to-degree (Ackerman, Kanfer & Calderwood, 2013; Evans, 2019; Smith, Hurwitz & Avery, 2017).

The nationwide AP reform in 2014 (Chemistry) and 2015 (Physics) implemented a variety of curricular changes, many of which aligned with the Framework for K-12 Science Education Standards (NRC) and derivative Next Generation Science Standards (NGSS) reform (NGSS Lead States, 2013) to increase its focus on scientific inquiry, depth of understanding, and reasoning while decreasing its former emphasis on memorization and rote learning (Magrogan, 2014). These substantial curricular changes led teachers to engage in a variety of PD learning activities to be prepared for teaching new or restructured AP courses to prepare their students for the revised AP exams (Fischer, Eisenkraft, Fishman, Hübner & Lawrenz, 2018).

In this study we used data from the first year of the AP examination after the reform in Chemistry and Physics. Teacher-level data were collected with a web-based survey sent to all AP Chemistry and Physics teachers in the U.S. unless they requested to be placed on a College Board 'do not contact' list. Fischer (2017) includes an example of a full teacher survey instrument used in this study. Descriptive data for the schools were directly provided by the College Board. In total, this study included data from 3,725 teachers (53 % female) with an average of $M = 46.4$ years ($SD = 11.0$). 2,145 participants (57 %) were Chemistry and 1,580 (42 %) were Physics teachers.

Non-response analyses of schools used in this study with all schools in the U.S. indicated only minor differences at the school level ($d = 0.01 – 0.08$) regarding the school-level variables used in this study.

Measures

The *dependent variable* used in the analysis is the indicated importance of a teachers' choice to enroll in PD activities because it "provides opportunities to interact with other teachers". This categorical variable is treated as continuous for the regression analyses. The categories were derived from teachers' three top ranked motivations (out of a list of nine reasons to participate, see Table 2) from 0 = not ranked, 1 = ranked as third most important reason, 2 = ranked as second most important reason to 3 = ranked as most important reason.

Independent variables. On the school-level, we included schools' overall competitiveness (measured through the current average high school grade point average (GPA) of students taking the AP exams), school size (number of all enrolled students), overall socioeconomic status (percentage of students eligible for free or reduced lunch), and school funding level (district level funding of instructional materials). In addition, we included a categorical variable representing the school neighborhood (Urban, Suburban, Town, and Rural, dummy-coded).

On the teacher level, we included t age, gender (1 = female, 0 = male), professional training level (1: Associate's Degree, 2: Bachelor's Degree, 3: Master's Degree, 4: Certificate of Advanced Study, 5: Doctoral Degree), and a teacher self-efficacy scale based

PD Category	PD Activity
Formal face-to-face PD (*n* = 3,320)	AP Summer Institute
	1-Day Workshop
	Transition to inquiry-based labs
	Laying the foundations
	Leadership Academy
	1-Day reasoning skills workshop
Informal face-to-face PD (*n* = 1,670)	Day with an AP reader
	Teacher-initiated meeting (district)
	Mentoring or one-one-coaching
	Conferences
	AP exam reader
	AP consultant
Formal online PD (*n* = 574)	Transition to inquiry-based labs
	Overview of AP course
	Webcast: Photoelectron spectroscopy
Informal online PD (*n* = 2,272)	AP Insight
	Quantitative skills
	The labs
	AP central
	APTC
	Online communities by NSTA

Tab. 1: Overview of the PD activities.

on items such as (a) students perform better because of my extra effort, (b) student scores improve because of my teaching, (c) my teaching can overcome student backgrounds, (d) extra effort in teaching produces little change (see Fischer et al., 2020, for more detail).

On the PD-level, we differentiated the dimensions of formality (formal vs. informal) and modality (online vs. face-to-face) resulting in four categories: formal face-to-face, informal face-to-face, formal online, and informal online. Table 1 describes how each PD activity is categorized within this framework.

Data Analysis

All statistical analyses were performed in Mplus 8.1 (Muthén & Muthén, 1998–2017). The unit of analyses for all RQs is each individual PD participation (N = 7,836 PD participations) opposed to individual teachers.

To answer research question 1 regarding the importance of opportunities for collaborations with colleagues for teacher selection of PD activities, we first looked at descriptives (means and standard deviations) for all nine possible reasons to participate in PD. To analyze relationships between the rationale *opportunities for collaborations* of teachers to participate in PD and other rationales (e.g., convenience) we used correlation analyses.

To answer research question 2 regarding associations of PD, teacher, and school characteristics with the rationale *opportunities for collaborations* of teachers to participate in PD, we performed sequential regression models accounting for the nested structure of PD activities within teachers. We ran three models adding one block at a time: school variables (M1), teacher variables (M2), and PD characteristics (M3; full model). Since our dependent variable is a categorical variable treated as continuous for the regression analyses, we also ran logistic regression models using MLR estimator in which we defined the dependent variable as an ordered categorical variable to check the robustness of our results.

Missing data existed in all our analyses due to *item non-response.* However, the percentage of missing data (approx. 4%) across all independent and dependent variables was relatively small. Nonetheless, to address the missing data, we employed full information maximum likelihood (FIML) estimation in all our analyses as recommended compared to alternative approaches like listwise or pairwise deletion (Graham, 2012).

Results

The mean scores for the selection of the top three of the nine provided rationale choices indicated that teachers most strongly agree that they attend PD activities because of the content of the redesigned course (M = 1.16, SD = 1.23) and because of the perceived opportunity to share ideas with other teachers (M = 0.87, SD = 1.18). In contrast, teachers tended not to choose the PD activities because it was required (M = 0.17, SD = 0.62) or because they wanted to learn about the pedagogy for the redesigned course (M = 0.32, SD = 0.73).

The perceived opportunity to exchange with other teachers showed a weak to small statistically significant negative correlation with all other rationale ($-.21 \leq r \leq -.04$; see Table 3). This indicates that teachers who choose connecting with colleagues as one of their top three rationale for PD activities place less importance on other rationale. Thus, our results suggest that the perceived opportunity to collaborate is an important aspect in teachers' selection of PD activities in the context of the AP reform.

Rationale	*N*	*M*	*SD*	No importance (0) in %	Low importance (1) in %	Medium importance (2) in %	High importance (3) in %
Emphasized content for the redesigned course	7,803	1.16	1.23	47.70	10.80	19.20	22.30
Perceived opportunity to interact with other teachers	7,809	0.87	1.18	59.80	10.90	12.00	17.30
Emphasized guidance on structure and planning for the redesigned course	7,798	0.71	1.02	62.10	13.80	15.10	9.00
Convenience	7,804	0.65	0.99	65.20	12.80	14.00	8.00
Costs little or no money	7,793	0.51	0.94	65.20	12.80	14.00	8.00
Emphasized the redesigned labs	7,802	0.42	0.83	76.50	9.20	10.10	4.20
Provider had a strong reputation	5,554	0.34	0.87	85.20	3.70	3.30	7.80
Emphasized pedagogy for the redesigned course	7,793	0.32	0.73	80.80	9.60	6.40	3.20
Requirement	7,822	0.17	0.62	92.00	2.80	1.60	3.60

Note. Range for all rationales is 0–3.

Tab. 2: Descriptive statistics for teachers' rationales to participate in PD.

	N	*r*	*p*
Emphasized content for the redesigned course	7,780	−.21	< .001
Emphasized guidance on structure and planning for the redesigned course	7,776	−.12	< .001
Convenience	7,785	−.13	< .001
Costs little or no money	7,772	−.09	< .001
Emphasized the redesigned labs	7,780	−.15	< .001
Provider had a strong reputation	5,537	−.12	< .001
Emphasized pedagogy for the redesigned course	7,771	−.11	< .001
Requirement	7,798	−.04	< .001

Tab. 3: Correlations Between the Rationale Perceived Opportunity to Interact With Other Teachers and Other PD Participation Rationales.

	M1			M2			M3		
	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*
School-Level									
GPA	.01	.01	.931	−.01	.01	.925	−.01	.01	.444
Rural (Reference suburban)	−.02	.01	.108	−.02	.01	.097	−.02	.01	.189
Town (Reference suburban)	.01	.01	.882	.01	.01	.869	.01	.01	.722
Urban (Reference suburban)	.03	.02	.085	.03	.02	.077	.02	.01	.116
School Size	.01	.01	.551	.01	.01	.551	.01	.01	.551
Percentages of Students in Lunchprogram	.01	.01	.460	.01	.01	.481	.01	.01	.421
Funding	−.02	.01	.221	−.02	.01	.242	−.02	.01	.185
Teacher-Level									
Age				.02	.01	.261	**.03**	**.01**	**.026**
Gender (0 = male, 1 = female)				−.01	.01	.862	.01	.01	.669
Degree				.01	.01	.879	.01	.01	.930
Self-Efficacy				**.05**	**.02**	**.001**	**.06**	**.02**	**< .001**
PD-Level									
Informal FtF PD (Reference FtF Formal)							**.24**	**.01**	**< .001**
Formal Online PD (Reference FtF Formal)							**−.13**	**.01**	**< .001**
Informal Online PD (Reference FtF Formal)							**.03**	**.01**	**.031**
R^2, R^2_{adj}	.002, .001			.005, .003			.088, .086		

Note. N = 7,639 PD activities. The statistically significant regression weights are marked in bold. FtF = Face-to-Face.

Tab. 4: Results of Regressions of the Importance of the Rationale Perceived Opportunity to Exchange With Other Teachers.

	M1			M2			M3		
	β	*SE*	*p*	β	*SE*	*p*	β	*SE*	*p*
School-Level									
GPA	−.01	.01	.933	−.01	.01	.773	−.01	.01	.279
Rural (Reference suburban)	−.02	.01	.106	−.02	.01	.093	−.02	.01	.087
Town (Reference suburban)	.01	.01	.884	.01	.01	.897	.01	.01	.968
Urban (Reference suburban)	.02	.01	.076	.02	.01	.067	.02	.01	.134
School Size	.02	.01	.078	.02	.01	.078	.01	.01	.662
Percentages of Students in Lunchprogram	.01	.01	.560	.01	.01	.621	.01	.01	.413
Funding	−.01	.01	.418	−.01	.01	.468	−.01	.01	.278
Teacher-Level									
Age				.01	.01	.347	**.03**	**.01**	**.025**
Gender (0 = male, 1 = female)				−.01	.01	.801	.01	.01	.607
Degree				.01	.01	.723	−.01	.01	.675
Self-Efficacy				**.05**	**.01**	**.003**	**.06**	**.01**	**< .001**
PD-Level									
Informal FtF PD (Reference FtF Formal)							**.22**	**.01**	**< .001**
Formal Online PD (Reference FtF Formal)							**−.28**	**.02**	**< .001**
Informal Online PD (Reference FtF Formal)							.01	.01	.166

Note. *N* = 7,639 PD activities. The statistically significant regression weights are marked in bold. FtF = Face-to-Face.

Tab. 5: Logistic Regressions of the Importance of the Rationale Perceived Opportunity to Exchange With Other Teachers.

Research Question 2 focuses on characteristics of the schools, the teachers, and the selected PD activity as predictors for the choice *perceived opportunity to exchange with other teachers* (Table 4). At the school level, no statistically significant predictors could be identified. Adding the teacher level variables revealed a weak significant positive prediction of teacher self-efficacy. That is, the higher teachers perceived their self-efficacy, the more importance they attached to the rationale *perceived opportunity to exchange with other teachers.* Adding the PD level variables, we found a significant positive prediction for informal face-to-face PD (compared to 'formal FtF PD'). That is, teachers put a higher importance on the social aspect of PD when selecting informal face-to-face PD. Moreover, we found a small negative prediction for formal online PD (contrasting 'formal FtF PD'). This finding indicates that teachers put less importance on the social aspect when selecting formal online PD compared to formal FtF PD. Finally, there was also a weak positive prediction for informal online PD (compared to 'formal FtF PD'). That is, teachers put a little more importance on the social aspect when selecting informal online PD compared to formal FtF PD. To check robustness of our findings, we also ran logistic regression models in which we defined the dependent variable as an ordered categorical variable. With one exception, we were able to replicate the results presented: The weak positive prediction for informal online PD was no longer statistically significant (Table 5).

Overall, the findings illustrate that the rationale *perceived opportunity to exchange with other teachers* is primarily related to the characteristics of the selected PD activity and not, or only to a very small extent, to the characteristics of teachers or their school.

Discussion

The purpose of this study was to examine teachers' rationales for participating in PD activities. We were particularly interested in the individually perceived importance of the social aspect of PD participation because of its rather universal motive to participate in PD. Therefore, we examined whether this reason was related to school-level, teacher-level, and/or PD-level characteristics. To this end, we utilized data from more than 3,700 teachers surveyed in the project *Professional Development and Adoption Variation Related to the Revised Advanced Placement Curriculum* (PD-RAP; Fischer, Fishman, et al. 2018; Fischer et al., 2020).

Regarding the first research question, the results support our assumption that the social component is a driving force in PD engagement, only topped by teachers' rationale to learn about the content of the redesigned course. This is in line with the existing literature, as previous research almost universally showed the importance of the social aspect for teachers when selecting PD activities (e.g., Appova & Arbaugh, 2018; Hauk et al., 2022). However, this finding is not as intuitive as it might seem at first glance. For instance, Smith and Kovacs (2011) described that implementing standards-based reform puts pressure on teachers to adopt them, for example, to raise scores on state tests. This pressure could explain why learning about the content of the redesigned course was the

most important reason for choosing a PD activity. However, we found that the reasons related to AP reform did not eclipse the social motive, likely because building collective and collaborative connections with colleagues is a process that builds teacher resilience during stressful times of policy reform (Gu, 2014).

The perceived opportunity to interact with other teachers and other rationales are not independent of each other since they are not mutually exclusive. That choice of PD is driven by multiple reasons highlights the complex decision-making process teachers face when choosing a PD activity. While in our study, the social motive was effectively unrelated to other motives, other studies found positive associations (e.g., D. Richter et al., 2019). We cannot rule out that this discrepancy is due to the ranking procedure of reasons implemented in our study which puts constraints on possible correlations.

With respect to the second research question, this study linked teachers' PD participation rationales to teacher-level, and PD-level characteristics while school variable were not relevant predictors. Of all the variables, PD-level characteristics were most strongly associated with the importance of the motive *perceived opportunity to exchange with other teachers.* That is, rationales for participating in PD differ between activities with different modalities (e.g., FtF or online). Specifically, we found that teachers who want to exchange with their colleagues are more likely to choose FtF than online PD activities and more likely to choose informal than formal PD activities. This finding can be explained in two ways: First, studies from psychology and education indicated that learners prefer FtF learning for communication purposes when generating shared knowledge or building interpersonal relationships, and that FtF interaction in stressful situations leads to greater emotional support than in digital supported interactions (Paechter & Maier, 2010; Holtzman, DeClerck, Turcotte, Lisi & Woodworth, 2017). Second, unlike formal PD activities, informal PD activities do not follow a predefined curriculum (Desimone, 2009). Rather, they are characterized by teachers organizing their own learning process, interacting, and discussing with colleagues, sharing information, and learning from others (Kyndt, Gijbels, Grosemans & Donche, 2016).

Moreover, we found that teachers with higher levels of self-efficacy placed more importance on this social component for their choice of PD, which is consistent with previous findings (e.g., Durksen et al., 2017). One possible path for exploring this finding could be the positive relationship between self-efficacy and extraversion (Perera, Granziera & McIlveen, 2018; E. Richter, Lucksnat, Redding & D. Richter, 2022), as extraverts tend to seek social attention and build larger advice networks (Malcolm, Saxton, McCarty, Roberts & Pollet, 2021; Paunonen, 2003).

Although this study was able to underline the relevance of the rationale *social contact* in the selection of PD activities, we would also like to point out the limitations of this study. First, our findings showed that personal-, school- and PD-level characteristics can explain only a small part of the variance of this motivation to engage in PD. Against this backdrop, it is important to keep in mind that we assessed teachers' rationales for participating in PD activities with a single item that addresses the global perceived opportunity to interact with others. However, teacher collaboration involves more than just exchanging, which is why a more elaborate approach to capturing this rationale might

be fruitful (Muckenthaler, Tillmann, Weiß & Kiel, 2020; Vangrieken et al., 2015). This means that in this study we only focused on one aspect of the teacher collaboration and conclusions are limited to this aspect. Additionally, the low variance explanation may also indicate that important variables were not included in the analyses. Furthermore, teachers' PD participation and arguably their motives may change over time (Hildebrandt & Eom, 2011; D. Richter, Kunter, Klusmann, Lüdtke & Baumert, 2011) which cannot be analyzed with a cross-sectional study. At the same time, rationales for PD participation may be related to individual resources and barriers to PD participation (E. Richter, D. Richter & Marx, 2018). Longitudinal patterns of reasons to participate in PD and individual resources and barriers for PD participation should be considered in future studies.

Second, likewise a consequence of the cross-sectional approach, we cannot interpret teachers' rationales for participating in PD activities as a cause even though it is more plausible than the opposite causal direction. In this context, it is important to realize that teachers' PD activities represent past behaviors. That is, teachers had taken these PD activities before we assessed the rationale for their choices.

Despite its limitations, our results have practical implications. As we have demonstrated that *social contact* is an important rationale for teachers to select PD activities, PD providers should incorporate forms of social contact into all forms of formal, informal, face-to-face, and online PD activities to foster teachers' interest in participating in PD. In this regard, there are some well-evaluated good-practice programs, both in German-speaking regions as well as other countries that provide examples of how to ensure high-level forms of teacher collaboration (e.g., Meyer, Richter, Richter & Gronostaj, 2020).

Literatur

Ackerman, P. L., Kanfer, R., & Calderwood, C. (2013). High School Advanced Placement and Student Performance in College: STEM Majors, Non-STEM Majors, and Gender Differences. *Teachers College Record, 115*(10), 1–43. https://doi.org/10.1177/016146811311501003.

Admiraal, W., Schenke, W., De Jong, L., Emmelot, Y., & Sligte, H. (2021). Schools as professional learning communities: What can schools do to support professional development of their teachers? *Professional Development in Education, 47*(4), 684–698. https://doi.org/10.1080/19415257.2019.1665573.

Aguilar, S. J., Rosenberg, J. M., Greenhalgh, S. P., Fütterer, T., Lishinski, A., & Fischer, C. (2021). A different experience in a different moment? Teachers' social media use before and during the COVID-19 pandemic. *AERA Open, 7,* 233285842110638. https://doi.org/10.1177/23328584211063898.

Appova, A., & Arbaugh, F. (2018). Teachers' motivation to learn: Implications for supporting professional growth. *Professional Development in Education, 44*(1), 5–21. https://doi.org/10.1080/19415257.2017.1280524.

Bigsby, J. B., & Firestone, W. A. (2017). Why teachers participate in professional development: Lessons from a schoolwide teacher study group. *The New Educator, 13*(1), 72–93. https://doi.org/10.1080/1547688X.2015.1063743.

Borko, H., Jacobs, J., & Koellner, K. (2010). Contemporary approaches to teacher professional development. In P. Peterson, E. Baker, & B. McGaw (Eds.), *International Encyclopedia of Education* (pp. 548–556). Oxford: Academic Press.

Boshier, R., & Riddell, G. (1978). Education participation scale factor structure for older adults. *Adult Education Quarterly, 28*(3), 165–175. https://doi.org/10.1177/074171367802800303.

Butler, D. L., Lauscher, H. N., Jarvis-Selinger, S., & Beckingham, B. (2004). Collaboration and self-regulation in teachers' professional development. *Teaching and Teacher Education, 20*(5), 435–455. https://doi.org/10.1016/j.tate.2004.04.003.

Buttimer, C. J., Littenberg-Tobias, J., & Reich, J. (2022). Designing online professional learning to support educators to teach for equity during COVID and black lives matter. *AERA Open, 8,* 233285842110677. https://doi.org/10.1177/23328584211067789.

Carpenter, J. P., & Krutka, D. G. (2014). How and why educators use twitter: A survey of the field. *Journal of Research on Technology in Education, 46*(4), 414–434. https://doi.org/10.1080/15391523.2014.925701.

Carpenter, J. P., Morrison, S. A., Craft, M., & Lee, M. (2020). How and why are educators using Instagram? *Teaching and Teacher Education, 96,* 103149. https://doi.org/10.1016/j.tate.2020.103149.

Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). *Effective teacher professional development.* Palo Alto, CA: Learning Policy Institute. https://learningpolicyinstitute.org/sites/default/files/product-files/Effective_Teacher_Professional_Development_REPORT.pdf [07/09/2022].

De Jong, L., Meirink, J., & Admiraal, W. (2019). School-based teacher collaboration: Different learning opportunities across various contexts. *Teaching and Teacher Education, 86,* 102925. https://doi.org/10.1016/j.tate.2019.102925.

De Neve, D., & Devos, G. (2017). How do professional learning communities aid and hamper professional learning of beginning teachers related to differentiated instruction? *Teachers and Teaching, 23*(3), 262–283. https://doi.org/10.1080/13540602.2016.1206524.

Dede, C., Eisenkraft, A., Frumin, K., & Hartley, A. (Eds.). (2016). *Teacher learning in the digital age: Online professional development in STEM education.* Cambridge, MA: Harvard Education Press.

Desimone, L. M. (2009). Improving impact studies of teachers' professional development. *Educational Researcher, 38*(3), 181–199. https://doi.org/10.3102/0013189X08331140.

Dille, K. B., & Røkenes, F. M. (2021). Teachers' professional development in formal online communities: A scoping review. *Teaching and Teacher Education, 105,* 103431. https://doi.org/10.1016/j.tate.2021.103431.

Doğan, S., & Adams, A. (2018). Effect of professional learning communities on teachers and students: Reporting updated results and raising questions about research design. *School Effectiveness and School Improvement, 29*(4), 634–659. https://doi.org/10.1080/09243453.2018.1500921.

DuFour, R., & Eaker, R. (1998). *Professional learning communities at work: Best practices for enhancing student achievement.* Bloomington, IN: Solution Tree.

Durksen, T. L., Klassen, R. M., & Daniels, L. M. (2017). Motivation and collaboration: The keys to a developmental framework for teachers' professional learning. *Teaching and Teacher Education, 67,* 53–66. https://doi.org/10.1016/j.tate.2017.05.011.

Evans, B. J. (2019). How college students use advanced placement credit. *American Educational Research Journal, 56*(3), 925–954. https://doi.org/10.3102/0002831218807428.

Fischer, C. (2017). *Examining forms and frames for science teacher learning related to large-scale reforms: A multi-manuscript dissertation.* Doctoral dissertation, University of Michigan.

Fischer, C., Eisenkraft, A., Fishman, B., Hübner, N., & Lawrenz, F. (2018). Adapting to the large-scale advanced placement chemistry reform: An examination of teachers' challenges and instructional practices. *Journal of Chemical Education, 95*(10), 1701–1710. https://doi.org/10.1021/acs.jchemed.8b00151.

Fischer, C., Fishman, B., Dede, C., Eisenkraft, A., Frumin, K., Foster, B., Lawrenz, F., Levy, A. J., & McCoy, A. (2018). Investigating relationships between school context, teacher professional development, teaching practices, and student achievement in response to a nationwide science reform. *Teaching and Teacher Education, 72,* 107–121. https://doi.org/10.1016/j.tate.2018.02.011.

Fischer, C., Fishman, B., & Schoenebeck, S. Y. (2019). New contexts for professional learning: Analyzing high school science teachers' engagement on Twitter. *AERA Open, 5*(4), 233285841989425. https://doi.org/10.1177/2332858419894252.

Fischer, C., Foster, B., Mccoy, A., Lawrenz, F., Dede, C., Eisenkraft, A., Fishman, B. J., Frumin, K., & Levy, A. J. (2020). Identifying levers related to student performance on high-Stakes science exams: Examining school, teaching, teacher, and professional development characteristics. *Teachers College Record: The Voice of Scholarship in Education, 122*(2), 1–64. https://doi.org/10.1177/016146812012200202.

Fischer, C., Witherspoon, E., Nguyen, H., Feng, Y., Fiorini, S., Vincent-Ruz, P., Mead, C., Bork, W. N., Matz, R. L., & Schunn, C. D. (2021). *Advanced placement course credit and undergraduate student success in gateway science courses* [Preprint]. Open Science Framework. https://doi.org/10.31219/osf.io/6zhqw.

Fishman, B., Fischer, C., Kook, J., Levy, A., Jia, Y., Eisenkraft, A., McCoy, A., Lawrenz, F., Dede, C., & Frumin, K. (2014). *Professional development for the redesigned AP Biology exam: Teacher participation patterns and student outcomes.* Paper presented at the 2014 annual meeting of the American Educational Research Association, Philadelphia, PA.

Frumin, K., Dede, C., Fischer, C., Foster, B., Lawrenz, F., Eisenkraft, A., Fishman, B., Jurist Levy, A., & McCoy, A. (2018). Adapting to large-scale changes in Advanced Placement Biology, Chemistry, and Physics: The impact of online teacher communities. *International Journal of Science Education, 40*(4), 397–420. https://doi.org/10.1080/09500693.2018.1424962.

Fütterer, T., Hoch, E., Stürmer, K., Lachner, A., Fischer, C., & Scheiter, K. (2021). Was bewegt Lehrpersonen während der Schulschließungen? – Eine Analyse der Kommunikation im Twitter-Lehrerzimmer über Chancen und Herausforderungen digitalen Unterrichts [Concerns of teachers during school closings: analyzing communication in the twitter-lehrerzimmer regarding opportunities and challenges of digital teaching]. *Zeitschrift für Erziehungswissenschaft,* 1–35. https://doi.org/10.1007/s11618-021-01013-8.

Garet, M. S., Porter, A. C., Desimone, L. M., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? *American Educational Research Journal, 38*(4), 915–945. https://doi.org/10.3102/00028312038004915.

Gast, I., Schildkamp, K., & van der Veen, J. T. (2017). Team-based professional development interventions in higher Education: A systematic review. *Review of Educational Research, 87*(4), 736–767. https://doi.org/10.3102/0034654317704306.

Goddard, Y. L., Goddard, R. D., & Tschannen-Moran, M. (2007). A theoretical and empirical investigation of teacher collaboration for school improvement and student achievement in public elementary schools. *Teachers College Record: The Voice of Scholarship in Education, 109*(4), 877–896. https://doi.org/10.1177/016146810710900401.

Graham, J. W. (2012). *Missing data. Analysis and Design.* New York: Springer. https://doi.org/10.1007/978-1-4614-4018-5.

Gu, Q. (2014). The role of relational resilience in teachers' career-long commitment and effectiveness. *Teachers and Teaching, 20*(5), 502–529, https://doi.org/10.1080/13540602.2014.937961.

Haiyan, Q., & Allan, W. (2021). Creating conditions for professional learning communities (PLCs) in schools in China: The role of school principals. *Professional Development in Education, 47*(4), 586–598. https://doi.org/10.1080/19415257.2020.1770839.

Hauk, D., Gröschner, A., Rzejak, D., Lipowsky, F., Zehetner, G., Schöftner, T., & Waid, A. (2022). Wie hängt die Berufserfahrung mit der Bereitschaft zur Teilnahme an Fortbildungen zusammen? Eine empirische Analyse zur generellen Fortbildungsmotivation von Lehrpersonen [How is teachers' professional experience related to teachers' motivation to participate in professional development?]. *Zeitschrift für Erziehungswissenschaft.* https://doi.org/10.1007/s11618-022-01080-5.

Hildebrandt, S. A., & Eom, M. (2011). Teacher professionalization: Motivational factors and the influence of age. *Teaching and Teacher Education, 27*(2), 416–423. https://doi.org/10.1016/j.tate.2010.09.011.

Holtzman, S., DeClerck, D., Turcotte, K., Lisi, D., & Woodworth, M. (2017). Emotional support during times of stress: Can text messaging compete with in-person interactions? *Computers in Human Behavior, 71,* 130–139. https://doi.org/10.1016/j.chb.2017.01.043.

Hord, S. M. (1997). Professional learning communities: What are they and why are they important? *Issues About Change, 6*(1), 71–82. http://www.sedl.org/change/issues/issues61.html [07/07/2022].

Hübner, N., Fischer, C., Fishman, B., Lawrenz, F., & Eisenkraft, A. (2021). One program fits all? Patterns and outcomes of professional development during a large-scale reform in a high-stakes science curriculum. *AERA Open, 7*(1), 1–18. https://doi.org/10.1177/23328584211028601.

Hur, J. W., & Brush, T. A. (2009). Teacher participation in online communities: Why do teachers want to participate in self-generated online communities of K-12 teachers? *Journal of Research on Technology in Education, 41*(3), 279–303. https://doi.org/10.1080/15391523.2009.10782532.

Johannmeyer, K., & Cramer, C. (2021). Nachfrage und Auslastung von Fortbildungen für Lehrerinnen und Lehrer: Effekte struktureller und inhaltlicher Angebotsmerkmale [Demand for and participation rate of professional development courses for teachers: effects of structural and content-related characteristics of the courses]. *Zeitschrift für Erziehungswissenschaft, 24*(5), 1183–1204. https://doi.org/10.1007/s11618-021-01030-7.

Kao, C.-P., Wu, Y.-T., & Tsai, C.-C. (2011). Elementary school teachers' motivation toward web-based professional development, and the relationship with Internet self-efficacy and belief about web-based learning. *Teaching and Teacher Education, 27*(2), 406–415. https://doi.org/10.1016/j.tate.2010.09.010.

Krille, C. (2020). *Teachers' participation in professional development.* Cham: Springer. https://doi.org/10.1007/978-3-030-38844-7.

Krutka, D. G., Carpenter, J. P., & Trust, T. (2017). Enriching professional learning networks: A framework for identification, reflection, and intention. *TechTrends, 61*(3), 246–252. https://doi.org/10.1007/s11528-016-0141-5.

Kwakman, K. (2003). Factors affecting teachers' participation in professional learning activities. *Teaching and Teacher Education, 19*(2), 149–170. https://doi.org/10.1016/S0742-051X(02)00101-4.

Kyndt, E. Gijbels, D., Grosemans, I., & Donche, V. (2016). Teachers' everyday professional development: Mapping informal learning activities, antecedents, and learning outcomes. *Review of Educational Research, 86*(4), 1111–1150. https://doi.org/10.3102/0034654315627864.

Lee, J. C., Zhang, Z., & Yin, H. (2011). A multilevel analysis of the impact of a professional learning community, faculty trust in colleagues and collective efficacy on teacher commitment to students. *Teaching and Teacher Education, 27*(5), 820–830. https://doi.org/10.1016/j.tate.2011.01.006.

Leonard, L. J. (2002). Schools as professional communities: Addressing the collaborative challenge. *International Electronic Journal for Leadership in Learning, 6*(17).

Malcolm, C., Saxton, T. K., McCarty, K., Roberts, S. G. B., & Pollet, T. V. (2021). Extraversion is associated with advice network size, but not network density or emotional closeness to network members. *Personality and Individual Differences, 168,* 110311. https://doi.org/10.1016/j.paid.2020.110311.

Magrogan, S. (2014). Past, present, and future of AP chemistry: A brief history of course and exam alignment efforts. *Journal of Chemical Education, 91*(9), 1357–1361. https://doi.org/10.1021/ed500096f.

Meyer, A., Hartung-Beck, V., Gronostaj, A., Krüger, S., & Richter, D. (2022). How can principal leadership practices promote teacher collaboration and organizational change? A longitudinal multiple case study of three school improvement initiatives. *Journal of Educational Change.* https://doi.org/10.1007/s10833-022-09451-9.

Meyer, A., Richter, D., & Hartung-Beck, V. (2020). The relationship between principal leadership and teacher collaboration: Investigating the mediating effect of teachers' collective efficacy. *Educational Management Administration & Leadership,* 174114322094569. https://doi.org/10.1177/1741143220945698.

Meyer, A., Richter, E., Richter, D., & Gronostaj, A. (2020). Professionalisierung von Schulleitungen am Beispiel der Werkstatt „Schule leiten". Evaluationsergebnisse einer Fortbildungsreihe für Schulleitungen zum Thema Schulentwicklung [Professionalization of school principals in the context of „Schule leiten". Results of the evaluation of a training program for school principals on school development]. *Die Deutsche Schule, 112*(3), 277–295. https://doi.org/10.31244/dds.2020.03.03.

Moudgalya, S. K., & Staudt Willet, K. B. (2019). Communities and clusters: User interactions in an online discussion forum for computer science education. *Society for Information Technology & Teacher Education International Conference,* 2291–2298.

Muckenthaler, M., Tillmann, T., Weiß, S., & Kiel, E. (2020). Teacher collaboration as a core objective of school development. *School Effectiveness and School Improvement, 31*(3), 486–504. https://doi.org/10.1080/09243453.2020.1747501.

Muthén, L. K., & Muthén, B. O. (1998–2017). *Mplus user's guide.* Muthén & Muthén. https://www.statmodel.com/download/usersguide/Mplus%20Users%20Guide%20v6.pdf [07/07/2022].

NGSS Lead States. (2013). *Next generation science standards: For states, by states.* Washington, D. C.: National Academies Press.

Nordgren, K., Kristiansson, M., Liljekvist, Y., & Bergh, D. (2021). Collegial collaboration when planning and preparing lessons: A large-scale study exploring the conditions and infrastructure for teachers' professional development. *Teaching and Teacher Education, 108,* 103513. https://doi.org/10.1016/j.tate.2021.103513.

Paechter, M., & Maier, B. (2010). Online or face-to-face? Students' experiences and preferences in e-learning. *The Internet and Higher Education, 13*(4), 292–297. https://doi.org/10.1016/j.iheduc.2010.09.004.

Park, S., Steve Oliver, J., Star Johnson, T., Graham, P., & Oppong, N. K. (2007). Colleagues' roles in the professional development of teachers: Results from a research study of National Board certification. *Teaching and Teacher Education, 23*(4), 368–389. https://doi.org/10.1016/j.tate.2006.12.013.

Paunonen, S. V. (2003). Big five factors of personality and replicated predictions of behavior. *Journal of Personality and Social Psychology, 84*(2), 411–424. https://doi.org/10.1037/0022-3514.84.2.411.

Penner-Williams, J., Díaz, E. I., & Gonzales Worthen, D. (2017). PLCs: Key PD component in learning transfer for teachers of English learners. *Teaching and Teacher Education, 65,* 215–229. https://doi.org/10.1016/j.tate.2017.03.014.

Perera, H. N., Granziera, H., & McIlveen, P. (2018). Profiles of teacher personality and relations with teacher self-efficacy, work engagement, and job satisfaction. *Personality and Individual Differences, 120,* 171–178. https://doi.org/10.1016/j.paid.2017.08.034.

Richter, D., Kleinknecht, M., & Gröschner, A. (2019). What motivates teachers to participate in professional development? An empirical investigation of motivational orientations and the uptake of formal learning opportunities. *Teaching and Teacher Education, 86.* https://doi.org/10.1016/j.tate.2019.102929.

Richter, D., Kunter, M., Klusmann, U., Lüdtke, O., & Baumert, J. (2011). Professional development across the teaching career. *Teaching and Teacher Education, 27*(1), 116–126. https://doi.org/10.1016/j.tate.2010.07.008.

Richter, D., & Schellenbach-Zell, J. (2016). *Fort-und Weiterbildung von Lehrkräften in Schleswig-Holstein: Ergebnisse einer Befragung im Jahr 2016 [Professional development of teachers in Schleswig-Holstein: results of a survey in 2016].* Institut für Qualitätsentwicklung an Schulen Schleswig-Holstein.

Richter, E., Carpenter, J., Meyer, A. & Richter, D. (2022). Instagram as a platform for teacher collaboration and digital social support. *Computers & Education.* 104624. https://doi.org/10.1016/j.compedu.2022.104624.

Richter, E., Lucksnat, C., Redding, C., & Richter, D. (2022). Retention intention and job satisfaction of alternatively certified teachers in their first year of teaching. *Teaching and Teacher Education, 114,* 103704. https://doi.org/10.1016/j.tate.2022.103704.

Richter, E., Marx, A., Huang, Y., & Richter, D. (2020). Zeiten zum beruflichen Lernen: Eine empirische Untersuchung zum Zeitpunkt und der Dauer von Fortbildungsangeboten für Lehrkräfte [Time for professional learning: An empirical study about timing and duration of teacher training]. *Zeitschrift Für Erziehungswissenschaft, 23*(1), 145–173. https://doi.org/10.1007/s11618-019-00924-x.

Richter, E., Richter, D., & Marx, A. (2018). Was hindert Lehrkräfte an Fortbildungen teilzunehmen? [What stops teachers from participating in professional development?] *Zeitschrift Für Erziehungswissenschaft, 21*(5), 1021–1043. https://doi.org/10.1007/s11618-018-0820-4.

Rosenberg, J. M., Borchers, C., Dyer, E. B., Anderson, D., & Fischer, C. (2021). Understanding public sentiment about educational reforms: The Next Generation Science Standards on Twitter. *AERA Open, 7,* 233285842110242. https://doi.org/10.1177/23328584211024261.

Rosenberg, J. M., Greenhalgh, S. P., Wolf, L. G., & Koehler, M. J. (2017). Strategies, use, and impact of social media for supporting teacher community within professional development: The case of one urban STEM program. *Journal of Computers in Mathematics and Science Teaching, 36*(3), 255–267.

Rosenberg, J. M., Reid, J. W., Dyer, E. B., Koehler, M., Fischer, C., & McKenna, T. J. (2020). Idle chatter or compelling conversation? The potential of the social media-based #NGSSchat network for supporting science education reform efforts. *Journal of Research in Science Teaching, 57*(9), 1322–1355. https://doi.org/10.1002/tea.21660.

Rzejak, D., Künsting, J., Lipowsky, F., Fischer, E., Dezhgahi, U., & Reichhardt, A. (2014). Facetten der Lehrerfortbildungsmotivation [Facets of teacher professional development motivation]. *Journal for Educational Research Online, 6*(1), 139–159.

Sancar, R., Atal, D., & Deryakulu, D. (2021). A new framework for teachers' professional development. *Teaching and Teacher Education, 101,* 103305. https://doi.org/10.1016/j.tate.2021.103305.

Sass, T. R., Hannaway, J., Xu, Z., Figlio, D. N., & Feng, L. (2012). Value added of teachers in high-poverty schools and lower poverty schools. *Journal of Urban Economics, 72*(2-3), 104–122. https://doi.org/10.1016/j.jue.2012.04.004.

Sims, S. (2017). *TALIS 2013: Working conditions, teacher job satisfaction and retention* (Department for Education Statistical Working Paper). UK Department of Education.

Smith, J., & Kovacs, P. E. (2011). The impact of standards-based reform on teachers: the case of 'No Child Left Behind'. *Teachers and Teaching, 17*(2), 201–225. https://doi.org/10.1080/13540602.2011.539802.

Smith, J., Hurwitz, M., & Avery, C. (2017). Giving college credit where it is due: Advanced placement exam scores and college outcomes. *Journal of Labor Economics, 35*(1), 67–147. https://doi.org/10.1086/687568.

Sprott, R. A. (2019). Factors that foster and deter advanced teachers' professional development. *Teaching and Teacher Education, 77,* 321–331. https://doi.org/10.1016/j.tate.2018.11.001.

Stoll, L., Bolam, R., McMahon, A., Wallace, M., & Thomas, S. (2006). Professional learning communities: A review of the literature. *Journal of Educational Change, 7*(4), 221–258. https://doi.org/10.1007/s10833-006-0001-8.

The College Board. (2020). *AP Cohort Data Report.* https://reports.collegeboard.org/media/pdf/Program-Summary-Report-2020_1.pdf [07/21/2022].

Toropova, A., Myrberg, E., & Johansson, S. (2021). Teacher job satisfaction: the importance of school working conditions and teacher characteristics. *Educational Review, 73*(1), 71–97. https://doi.org/10.1080/00131911.2019.1705247.

Trust, T., Krutka, D. G., & Carpenter, J. P. (2016). "Together we are better": Professional learning networks for teachers. *Computers & Education, 102,* 15–34. https://doi.org/10.1016/j.compedu.2016.06.007.

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.

Vangrieken, K., Grosemans, I., Dochy, F., & Kyndt, E. (2017). Teacher autonomy and collaboration: A paradox? Conceptualising and measuring teachers' autonomy and collaborative attitude. *Teaching and Teacher Education, 67,* 302–315. https://doi.org/10.1016/j.tate.2017.06.021.

Voelkel, R. H., & Chrispeels, J. H. (2017). Understanding the link between professional learning communities and teacher collective efficacy. *School Effectiveness and School Improvement, 28*(4), 505–526. https://doi.org/10.1080/09243453.2017.1299015.

Yoon, S. A., Miller, K., Richman, T., Wendel, D., Schoenfeld, I., Anderson, E., & Shim, J. (2020). Encouraging collaboration and building Community in Online Asynchronous Professional Development: Designing for social capital. *International Journal of Computer-Supported Collaborative Learning, 15*(3), 351–371. https://doi.org/10.1007/s11412-020-09326-2.

Zhang, X., Admiraal, W., & Saab, N. (2021). Teachers' motivation to participate in continuous professional development: Relationship with factors at the personal and school level. *Journal of Education for Teaching, 47*(5), 714–731. https://doi.org/10.1080/02607476.2021.1942804.

Zusammenfassung: Die erfolgreiche Zusammenarbeit von Lehrkräften ist eine wichtige Voraussetzung für die berufliche Zufriedenheit und das Erleben von Selbstwirksamkeit bei Lehrkräften. Gelegenheiten zur Zusammenarbeit mit Kolleginnen und Kollegen sind zudem eine wichtige Grundlage für die Umsetzung von Veränderungsprozessen im Rahmen des beruflichen Lernens von Lehrkräften, die zu Verbesserungen in der eigenen Unterrichtspraxis und zu besseren Schülerleistungen führen können. Vor diesem Hintergrund untersuchen wir die Bedeutung von Möglichkeiten in Fortbildungen mit anderen Lehrkräften zusammenzuarbeiten für die Teilnahme an Fortbildungen im Rahmen der Advanced Placement (AP) Reform in den USA (N = 3 725 Lehrkräfte). Unsere Ergebnisse zeigen, dass die Möglichkeit der Zusammenarbeit mit anderen Lehrkräften bei der Auswahl von formellen und informellen Lernangeboten einer der Hauptgründe ist, warum sich Lehrkräfte für die Teilnahme entscheiden. Dieser Grund ist für alle Lehrkräfte gleichermaßen wichtig, weitgehend unabhängig von ihren beruflichen Merkmalen oder den Merkmalen ihrer Schule. Dieser Teilnahmegrund ist jedoch für Lehrkräfte besonders dann wichtig, wenn sie sich für die Teilnahme an einer informellen Lernmöglichkeit in Präsenz entscheiden. Die Ergebnisse machen deutlich, dass das Vorhandensein kollaborativer Strukturen in Fortbildungen die Teilnahme von Lehrkräften an Fortbildungen begünstigen kann.

Schlagworte: Kooperation, Lehrkräftefortbildung, sozialer Austausch

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