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Too Busy to Read, Too Important to Ignore: How Teachers Manage to Read Work-Related Literature in Their Day-to-Day Work

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Abstract: Educational policy and research demand evidence-orientation from teachers in their professional activities. However, how teachers should integrate this requirement into their everyday work remains controversial. The resources available to teachers—above all time—play a central role. Teachers are a very heterogeneous professional group that differs at least in terms of the subjects they teach. Using teacher data from PISA 2022, this study explores: (1) whether mathematics teachers differ from others in reading work-related literature, (2) whether there are distinct types of mathematics teachers based on time investment during a regular workweek, (3) how these types differ in mental health, job satisfaction, collaboration, and training needs, including the respective role of reading work-related literature, and (4) what conclusions can be drawn for education policy and practice. Data from 2516 teachers in Germany were analyzed using K-means clustering, mean comparisons, and Chi^2 tests to compare mathematics teachers with other subject teachers and examine time allocation with respect to the engagement in reading work-related literature. The results highlight the importance of categorizing teachers into specific subgroups and considering various factors affecting their teaching and commitment in professional development. For mathematics teachers, the findings offer initial insights into how their time investment impacts their ability to engage with work-related literature and the unique challenges they face. This has implications for their professional development and support.

Keywords: evidence-orientation in teaching; professional development; teacher activities; work-related literature; teacher cooperation; time allocation; PISA 2022; mathematics teachers

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1. Introduction

Evidence-orientation in teaching is now considered the standard for the teaching profession. Orienting one's own teaching activities to what the constantly evolving evidence shows requires teachers to be up to date. This applies both to the subjects they teach and to the field of educational science. In order to keep up to date, professional development courses, reading specialist literature, or exchanging ideas with experts in the field of schools and teaching are all suitable. However, all of this requires time—a resource that is a rare commodity in times of teacher shortages. The shortage of teachers, along with related challenges, such as the increased workload of those remaining in the profession, is currently being highlighted through various channels. At the same time, many efforts have been made in recent years to professionalize teacher training. Meanwhile, global networking is accelerating world affairs, making them increasingly complex. In light of this, is it not crucial—despite the shortage of teachers and the lack of time for those still in the field—to provide teachers with the best possible opportunities to engage with the latest empirical evidence throughout their careers? Or perhaps, is this need even more pressing precisely because of these challenges?

1.1. Evidence-Oriented Education and the Professional Development of In-Service Teachers

Evidence-oriented approaches to teaching are increasingly being introduced and implemented in school practice (e.g., Evidence-Based Education), with the understanding that high-quality teaching—while variable depending on context—can be developed, supported, and enhanced [1]. Unlike the focus in Anglo-American countries, where these initiatives already target in-service teachers, evidence-oriented education in German-speaking countries has concentrated on pre-service teacher training. Grounded on the standards for teacher education—a resolution of the German Standing Conference of Ministers of Education and Cultural Affairs [2]—teaching oriented towards evidence has become increasingly important in teacher education curricula. Accordingly, universities must provide student teachers with learning opportunities on how to integrate the latest scientific findings into their existing knowledge in order to inform their daily professional decisions in schools and classroom settings [3]. The overarching goal is to equip student teachers with the ability to continually update their subject knowledge through new research while deepening their understanding of pedagogy and teaching–learning processes—objectives aligned with requirements from both Germany and the European Commission [4].

In contrast, professional development for in-service teachers in Germany, typically known as the "third phase" of teacher education, has historically been given secondary priority in both policy and research [5]. The effectiveness of professional development courses, much like school-based teaching and learning, depends on various facets of provision and utilization [6]. A significant factor is the perception, processing, and application of these offerings by the participants themselves [6–8]. Notably, effective professional development is often characterized by a subject-specific focus—centered on a teaching topic, unit or particular didactic strategy [6,9].

Responding to Shulman's (1986) call for greater integration of subject content into research on teaching and learning in the classroom [10], many publications in STEM fields have addressed this need [11]. However, German-speaking educational researchers have recently critiqued the generalization of these STEM-based findings to other subjects, e.g., [12,13], advocating for an investigation into which aspects of teaching and learning are genuinely subject-specific and where broader generalizations can be applied [11,14]. A comparison of international studies analyzing subject-specific professional content knowledge—primarily in mathematics—has revealed divergent findings, attributed to cultural influences and structural differences in education and teacher-training systems [15]. For example, the United States lacks a formalized discipline of subject-specific didactics within teacher training, a component firmly embedded in German teacher education [15].

A special feature of the German education system is its federal structure and the associated sovereignty of the federal states in the education sector. Similar to other decentralized education systems, like Switzerland, Austria, Belgium, the USA, Canada, Mexico, Brazil, and India, education policies and practices may vary considerably from one region to another. However, while regions or states have significant autonomy, the national government often sets overarching guidelines or standards and often monitors the achievement of national educational goals through nationwide assessments. In Germany, all federal states have partially distinct legal regulations regarding the continuing education requirements for teachers [16]. It is remarkable that the structuring of these regulations is heterogeneous. The number of mandatory professional development hours per school year is specified only in a few federal states: Bavaria (15 h), Berlin (10 h), Bremen (30 h), and Hamburg (30 h). Additionally, only twelve federal states require that participation in professional development courses be documented [16]. To date, there has been limited research on the public reporting of various professional development programs in Germany, resulting in insufficient knowledge about actual attendance and implementation of these programs [16]. Somewhat more research can be found on the professional development behavior of teachers in other countries, especially the USA. For example, teachers' pursuit for internalized images of 'perfect' teaching and dissatisfaction with their own teaching are the main motivations for participating in professional development courses, while a lack of institutional and social

support in turn has a negative effect [17]. As particularly important for the transfer of 'learning' into their teaching practice, teachers value the opportunities for social interchange in professional learning communities [18]. Such team-based professional development interventions in higher education are also discussed regarding their effect on collegiality, critical reflection, teaching approach, pedagogical knowledge, and teacher identity [19]. Beyond that, the first rationale for taking part in a specific professional development course, following the emphasized content, is the perceived opportunity to interact with other teachers [20]. A more detailed analysis of the motivation to participate in professional development courses identified three profiles: interaction-motivated, reform-motivated, and convenience-motivated participation [21]. By considering two measurement points, Richter and coauthors find that each decision to participate is influenced by a combination of different motivations, which can vary at different times [21].

The comparison of TALIS 2018 and the German school barometer 2024 clearly shows that teachers in Germany participate much less in professional development courses than teachers in other countries [22,23]. Within Germany, based on data of the IQB National Assessment Studies in 2011 and 2012 and the IQB Trends in Student Achievement 2015, a higher participation rate in professional development courses was found in federal states with a concrete obligation or a burden of proof [24]. In another analysis of data from the IQB National Assessment Studies 2012, disengagement and perceived lack of quality proved to be barriers that actually affected teachers' withdrawal from professional development activity [25]. Meanwhile, the teachers surveyed in PISA 2015 and 2018 (N = 125,764) attribute great importance to professional development courses for professional success and job satisfaction, regardless of whether they were professionalized through regular teacher training, a lateral entry or a side entry [26].

1.2. Obstacles Teachers Face in Accessing Professional Development Amidst Teacher Shortages

The scheduling of professional development courses significantly impacts actual participation rates. When courses are held outside of instructional hours, they require additional, unpaid working time; conversely, if they occur during lesson time, teachers must be replaced, or classes must be canceled. These considerations align closely with the limited short-term options available to school administrators for addressing teacher shortages, which include either increasing the workload of current staff or reducing the breadth of the school curriculum [27]. The Standing Scientific Commission on Education Policy (SWK) recommends a systematic review of teachers' tasks and permanent positions for administration and other teaching staff in the context of teacher shortage [28]. Teachers leaving the profession or reducing their working hours due to job-related stress and demands exacerbate the teacher shortage itself [29]. Conversely, individual stress may escalate when personal standards are unattainable due to cancellations or reductions [30]. Individual measures, such as mindfulness or classroom management training, have proven to be effective approaches to health promotion, as have measures at an organizational and institutional level, which is why the SWK calls for the strengthening of such training as well as awareness-raising and corresponding support for teachers' health across the entire professional spectrum [28]. In the context of sustaining professionalism amid the teacher shortage, the SWK focuses solely on regular teacher training, contrasting it with lateral and side-entry pathways, as well as the ongoing training and post-qualification of educators for subjects and school types experiencing particular shortages. However, it does not address the concept of lifelong professional learning [28]. This phenomenon is particularly noteworthy, as fluctuations in the teacher labor market exert a direct and detrimental influence on teacher training. In periods of shortage, training pathways may be accelerated or admission criteria relaxed; conversely, during times of oversupply, both the teaching profession and university teacher education programs may suffer a decline in prestige, leading to a corresponding reduction in resources [27]. However, one proposed solution to alleviate the burden on teachers is to enhance the allocation of self-directed learning time for students [28].

1.3. Reading Work-Related Literature as Professional Development Within an Individualized Framework

Self-directed learning time could also serve as a valuable solution for the professional development of teachers. In addition to formal learning activities, opportunities for informal learning are continuously expanding. Among the general German population, 70% of adults aged 18–70 report having engaged in one to three informal learning activities in the past year [31]. Since the onset of the COVID-19 pandemic, digitally supported learning has garnered increased attention. Among the German working population aged 25–65, 28% engage in at least one of three online learning activities, in stark contrast to 61% of school and university students [31]. Participation in professional development courses driven by convenience was notably higher when the courses were conducted in an informal and online format [21].

In this context, open science and open educational resources have gained significant importance in teacher training in recent years. Given the continuously growing body of research literature and the challenging task of locating evidence relevant to specific issues or contexts, platforms such as the Clearing House Teaching and Learning (https://www.clearinghouse.edu.tum.de/, accessed on 14 October 2024) and the Research Monitor for Schools (https://www.forschungsmonitor-schule.de/, accessed on 14 October 2024) serve as vital interfaces between research and practice. The Clearing House Teaching and Learning disseminates research evidence through concise reviews of meta-analyses presented in various formats, ensuring the quality of the information is suitable for educational practitioners [32].

However, to implement the reading of work-related literature as measure of evidence-orientation in education, teachers and their principals need to integrate it into everyday school life. In general, the behavior of teachers plays a central role in the school development process [33]. Yet, the current state of research on evidence-oriented teaching reveals a large number of difficulties and barriers for teachers and student teachers [34]. First of all, teachers' skills in searching for, comprehending, and applying research findings have been identified as barriers to engaging with educational research [35]. While teachers' behavior plays a significant role, the organizational structure is even more critical for the implementation of evidence-oriented teaching. The lack of a supportive school culture and tradition for accessing research is often criticized, as is the insufficient provision of "time and space to find, read, share, and apply research-based knowledge" [35] (p. 56). Based on the data from PISA 2012, a perceived lack of sourcing skill and time was found to affect teachers' perceived irrelevance of research [36]. At the same time, teachers indicate a slightly greater appreciation of evidence-oriented practices than perceived irrelevance of research [36]. A view on the research sample, consisting of secondary mathematics teachers who have been trained and socialized according to their subject, occasioned the authors to the assumption of a higher familiarity with statistics and research methods in the responded teachers, compared with teachers of other subjects.

On the other hand, there are complaints about a lack of solutions, a lack of links to practice, and, as a result, a lack of practical relevance, which is already evident in the complex formulation of research reports [37]. Meanwhile, student teachers see less complexity in educational science compared to their subject disciplines, perceive it as less important than the didactics of their subjects, and the more skeptical they are about their beliefs, the less involved they are in educational science courses [38]. Albeit with a small effect among student teachers, the beliefs about the usefulness of educational theories and evidence have an impact on their choice as well as their use of scientific sources as supporting information before making a professional decision [39]. Furthermore, in an interview study, some teachers regret that they also left their connection to science behind when they finished their studies at the university [40].

Meanwhile, positive attitudes towards research and the implementation of evidence-oriented teaching in teacher educators were observed, even the ones with less research experience [41]. Discrepancies between positive attitudes and actual behavior of evidence-

oriented teaching may be consequences of various challenges in the implementation process, including resource-related challenges, like a lack of institutional support, knowledge-related challenges, like a lack of sourcing skills or judgment knowledge, and practice-related challenges, containing the difficulty to associate the daily teaching practice with research evidence [42].

1.4. Research Questions

Given the vast and continually expanding array of relevant specialized literature available to teachers, coupled with the concurrent scarcity of time and resources for regular professional development courses, it is essential to acknowledge the increasing significance of independent, individual engagement with specialized literature. To effectively assess and support this mode of personal professional development, continuous and comprehensive monitoring is necessary. To recognize discrepancies between the willingness to participate in this type of professional development as well as the perception of relevance and usefulness and the actual participation, the categories resource-related challenges, knowledge-related challenges, and practice-related challenges appear to be helpful [42]. In addition, the role of the social aspect, which is important for participation in professional development courses, should also be observed for this type of independent study.

One possibility for such continuous monitoring is (international) large scale assessment, such as the OECD's PISA study with its surveys of students, parents, principals, and teachers. Besides various scales on the organization and perception of everyday working life, the PISA 2022 teacher questionnaire inquires about individual reading of work-related literature within the last 12 months. This item aims to assess the current willingness of teachers to engage in self-directed exploration of research findings.

The country-specific aspects of teacher training, participation, and offers respectively obligations of professional development courses, which have repeatedly emerged in the previous section, imply that we should initially focus on one country, with Germany being the obvious choice. In addition to the different organizational frameworks in different countries, the different states of research on the various teaching subjects also play a role. In our research questions, we also want to keep in mind which facets of teaching and learning are subject specific and which can be generalized. Due to the focus on mathematical literacy and mathematics teaching in PISA 2022, the teacher survey dataset includes information on whether or not they teach mathematics. Even though this dataset does not include information on which additional subjects teachers instruct besides mathematics, we have chosen to specifically compare mathematics teachers with those who teach other subjects. In general, however, our analysis of subject-specific differences with regard to mathematics teachers is intended to provide an initial basis for the question of whether and in what circumstances the reading of work-related literature differs between teachers of different subjects. A possible influencing factor on subject-specific differences could be a larger amount of available literature due to the pioneering role of mathematics in studies on professional content knowledge. Furthermore, the sample of mathematics teachers in PISA 2012 was found to value teaching practices supported by research and data, while their perception of research as irrelevant was low [36]. Accordingly, we hypothesize that differences will emerge within the PISA 2022 cohort regarding the engagement with work-related literature between mathematics teachers and teachers of other subjects. This consideration informed the formulation of the first research question:

1. Do mathematics teachers differ from teachers of other subjects in terms of reading work-related literature?

To focus the lens a little more sharply, we refer to the finding that the teaching profession only allows professional development measures to a very limited extent—if at all—due to numerous other tasks and obstacles we have presented above. Hence, we intend to establish initial connections with different resource-related challenges and the activity of reading work-related literature as a willingness to engage with research findings. Assuming that the group of mathematics teachers is more homogeneous in their work-related activities

than the overall sample and also the group of teachers of other subjects, we take a closer look at the mathematics teachers in terms of their time used for work-related activities. The associated analyses are intended to tackle the second research question:

2. Are there differing types of mathematics teachers based on the time invested during a regular work week, and do they differ in reading work-related literature?

Third, in addition to perceived time available, however, the PISA 2022 teacher questionnaire also contains information on other factors possibly influencing not only the resource-related (e.g., mental health, cooperation) but also the knowledge-related (e.g., training needs) and practice-related challenges (e.g., job satisfaction). Potentially there could even be an effect of the time available on other influencing variables of the accomplishment of personal professional development. By taking a closer look at these aspects, we want to clarify the following third research question:

3. How do the types and groups differ related to their mental health, job satisfaction, cooperation, and training needs, and what role does reading work-related literature play in this?

Finally, we want to discuss what can be derived from these findings for continuous and comprehensive monitoring but also for the various stakeholders of the educational system. Therefore, we propose conclusions that may inform educational monitoring as well as policy and practice.

2. Materials and Methods

The data analyzed includes responses from $N = 2516$ full-time teachers in Germany, collected as part of PISA 2022 (https://www.oecd.org/en/data/datasets/pisa-2022-database.html, accessed on 14 October 2024). The sample was restricted to full-time teachers to mitigate distortions arising from varying part-time employment models and workloads. The distribution of working hours across different tasks is critical for our analysis; therefore, it was important that the scope of work exhibited minimal variance. The gender composition of the sample is nearly balanced, with females representing 51% and males 49%. Regarding demographic characteristics, the average age of participants is 44.26 years ($SD = 10.76$), with an average of 15.6 years of teaching experience ($SD = 10.31$) and an average age of 10.22 years at their current school ($SD = 8.13$), indicating the sample is representative of the expected demographics

2.1. Differences of Mathematics and Other Teachers in Reading Work-Related Literature

To clarify the first research question and in line with the focus of PISA 2022, the sample is divided into two groups: teachers of mathematics ($N = 832$) and teachers of other subjects ($N = 1684$). These groups do not diverge significantly from the overall sample regarding time working as a teacher and at the particular school. The mathematics group has a higher proportion of male teachers (46%/54%) than the group teaching other subjects (53%/47%). Comparing the age with the total sample, the mathematics teachers are significantly younger (($t_{\text{maths}}(1444.3) = 2.2207$; $p = 0.02$), $m_{\text{total}} = 44.3$; $m_{\text{maths}} = 43.3$), whereas the age of teachers of other subjects does not differ significantly from the total sample ($m_{\text{total}} = 44.3$; $m_{\text{other}} = 44.7$).

Particular emphasis is placed on the dichotomous item that inquires whether teachers have engaged with work-related literature (e.g., specialized journals, evidence-based articles, or theses) within the past 12 months. The differences between the two groups of teachers concerning this item will be analyzed using a Chi-squared (χ^2) test. Furthermore, correlations between the reading of work-related literature and other activities and competencies of teachers will also be investigated.

2.2. Activity Types of Mathematics Teachers

Mathematics teachers are categorized into distinct activity types using k-means clustering, based on the weekly time invested in their daily teaching responsibilities, to refine

the identification of this group and address the second research question. To analyze the invested time, missing data were imputed using Multiple Imputation by Chained Equations (mice). The descriptions of the activity types are derived from z-standardized invested times and correlations in commonly performed activities.

2.3. Perception of Various Resources or Needs

Correlations between the activity types and subject groups with respect to reading work-related literature were calculated using Fisher's Exact Test. Additionally, means of the subject groups—as well as the respective subgroups that do or do not read work-related literature—and activity types concerning perceived needs for professional development courses, collaborative work, job satisfaction, and mental health were compared employing *t*-tests, ANOVA, and Tukey's post-hoc tests. Separate comparative analyses of these factors for reading and non-reading subgroups within the different activity types could not be conducted due to insufficient subsample sizes, particularly among non-reading mathematics teachers engaged in socially interactive or corrective activities.

All analyses were performed in R, including the packages psych and mice.

3. Results

3.1. Research Question 1: Differences in Reading Work-Related Literature Between Mathematics Teachers and Teachers of Other Subjects

In a first step, the overall teacher sample was divided in two groups, depending on whether they teach mathematics or other subjects. The two groups differ significantly in terms of reading work-related literature in the last 12 months ($\chi^2(1) = 5.152$; $p < 0.05$), with mathematics teachers slightly less frequently reading work-related literature (75%/82%) than their colleagues.

Overall, identifying meaningful correlations—specifically those variables that hold practical relevance as indicated by prior research—presents several challenges. While the correlation coefficient may achieve significance with a small effect size due to the large sample size, the interpretation of these results must consistently integrate the current state of research to substantiate any conclusive statements. One notable correlation observed is between reading work-related literature and the ability to foster critical thinking skills in students ($m_{\text{reading}} = 3.00$; $m_{\text{no reading}} = 2.82$; $t(1780) = 4.3474$; $p < 0.001$; $g = 0.26$). The effect size is more pronounced when examining only the group of mathematics teachers ($m_{\text{reading}} = 2.97$; $m_{\text{no reading}} = 2.72$; $t(239) = 2.4108$; $p < 0.05$; $g = 0.36$).

3.2. Research Question 2: Activity Types of Mathematics Teachers

When examining how mathematics teachers allocate their time in daily work, three distinct types could be identified, each characterized by a different focus. These types are designated as follows: Teaching ($N = 567$), Correcting ($N = 94$), and Socially Interacting ($N = 171$). An illustration of the distribution of teachers across the subject groups and activity types is presented in Figure 1.

There are no discernible differences among the activity types regarding the time allocated for lesson planning. This finding is supported by a non-significant ANOVA conducted on this particular variable across the identified types. In contrast, all other variables exhibit significant mean differences, further validating the distinctions among the types. When examining mean values for the time invested per week, focusing exclusively on full-time teachers, it is evident that teaching constitutes the most time-intensive activity across all three types, even though one group dedicates more time to teaching than the others. Table 1 provides a detailed breakdown of the hours spent on each activity, along with the corresponding z-standardized values, categorized by the three identified activity types of mathematics teachers.

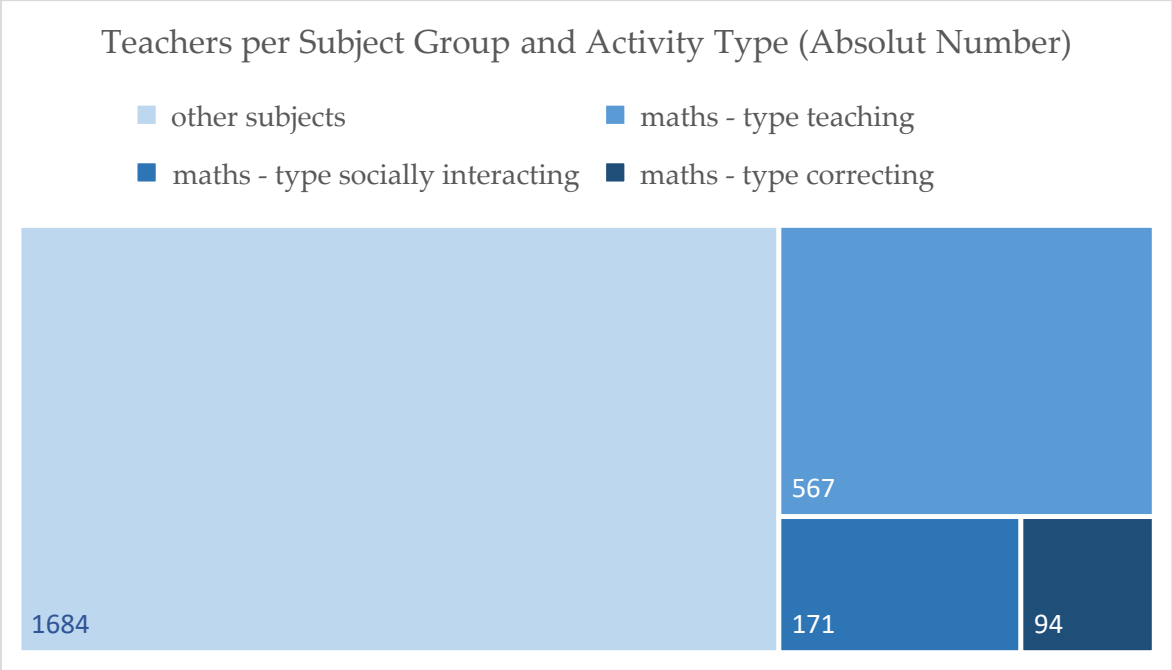


Figure 1. Illustration of the absolute numbers of teachers differing between subject groups and activity types.

Table 1. Comparison of invested time and z-standardized distance from overall mean.

	Teaching		Socially Interacting		Correcting	
	Time [1]	z [2]	Time	z	Time	z
teaching	20.72	0.191	17.42	−0.513	18.79	−0.221
individual planning or preparation of lessons either at school or out of school	9.86	0.051	8.80	−0.143	9.30	−0.051
team work and dialogue with colleagues within this school	2.50	−0.287	4.56	0.719	3.96	0.424
marking/correcting of student work	4.47	−0.284	4.92	−0.201	17.12	2.080
counselling students (incl. student supervision, mentoring, virtual counselling, career guidance, behavior guidance)	1.41	−0.271	3.82	1.004	1.56	−0.190
general administrative work (incl. communication, paperwork, other clerical duties)	2.25	−0.281	7.12	1.013	2.74	0.149
communication and co-operation with parents or guardians	1.10	−0.513	2.88	0.975	1.13	−0.233
engaging in extracurricular activities (e.g., sports and cultural activities after school)	0.67	−0.068	1.47	0.257	0.69	−0.059
overall invested time	42.98	−0.296	50.99	0.485	55.29	0.905

[1] mean per activity type of the invested time in the last work week, in hours. [2] z-standardized vector distance compared to the overall mean of the item.

An analysis of the three types of mathematics teachers in relation to their engagement with work-related literature reveals a significant result from Fisher's Exact Test ($p < 0.05$, V = 0.16). Although a slightly lower proportion of mathematics teachers engage with work-related literature compared to teachers of other subjects, the correcting type of mathematics teachers shows the least engagement, with only two-thirds reading work-related materials. In contrast, socially interacting mathematics teachers exhibit the highest engagement with such literature, at 88%. The most prevalent category, the teaching type, falls in the middle, with 72% engaging in work-related reading—slightly below the overall average for mathematics teachers. The percentages of teachers who reported reading work-related literature within the past 12 months are illustrated by subject groups and activity types in Figure 2.

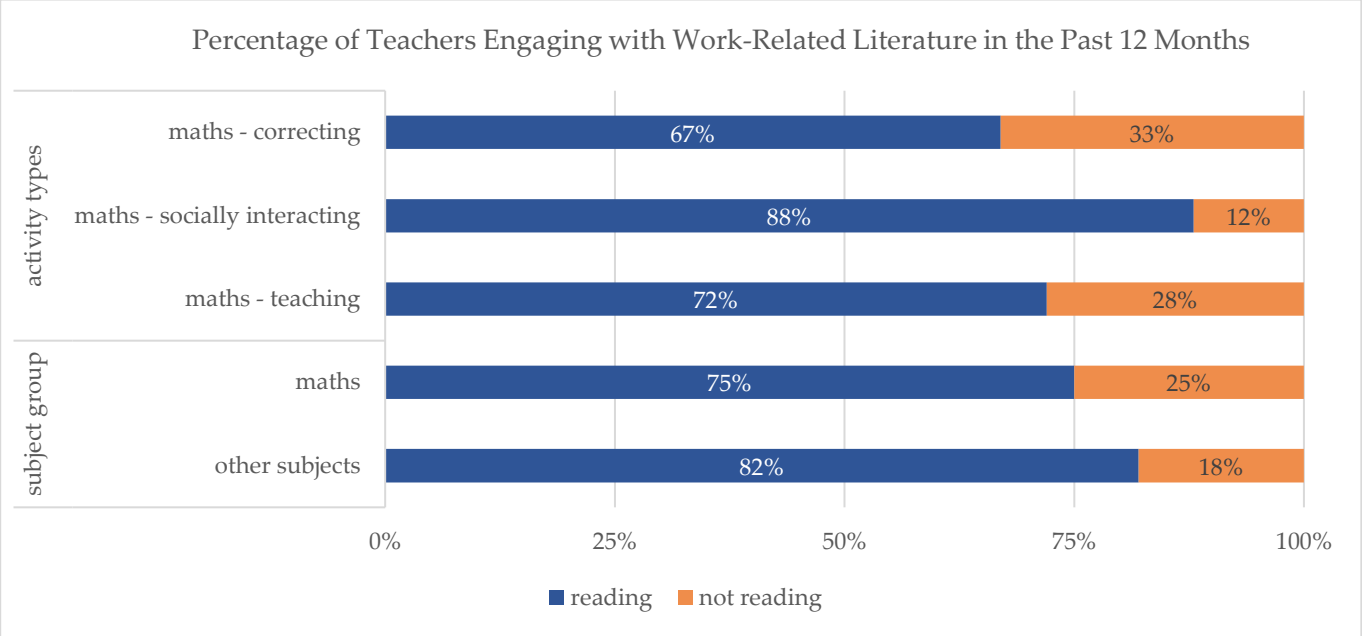


Figure 2. Comparison of percentage of teachers reading work-related literature per group and type.

3.3. Research Question 3: Perception of Various Resources or Needs

Further examination of the types of mathematics teachers concerning their perceived need for professional development courses revealed that significant differences exist only in relation to teaching equity and diversity. The differences identified in the ANOVA were further analyzed using a Tukey comparison of means, which clarified the effect. A mean difference was observed between the socially interacting type and the correcting type, with the socially interacting type reporting a lower perceived need for training. Differences among the other types were not statistically significant; however, tendencies approaching the 10% level of significance were noted regarding varying perceived training needs within the types. Specifically, for teaching students with special needs and in multicultural and multilingual environments, teachers categorized as the teaching type exhibited a lower perceived need for training in these areas compared to those in the correcting type. Additionally, the ANOVA revealed tendencies for mean differences related to the perceived needs for training in the use of evaluation results. Teachers who spend more time engaging in social interactions reported a reduced perceived need for training in this area compared to those classified as the correcting type. Notably, the perceived need for training regarding the use of evaluation results did not correlate with engagement in reading work-related literature. A comparison of the perceived needs for specific professional development courses across the three types of mathematics teachers is presented in Table 2.

When comparing the group of mathematics teachers to their counterparts in other subjects, it is not surprising to find that the perceived need for professional development courses in second language teaching is significantly higher among other subject teachers than among mathematics teachers. Additionally, there is a notable difference in mean perceived needs related to knowledge and understanding of their respective subject fields, with mathematics teachers reporting a lower perceived need. An examination of the reading and non-reading subgroups of mathematics teachers reveals no differences in their training needs.

It is important to note that the overall mean scores for perceived need are relatively low, indicating that the general demand for professional development in this area is not particularly high. A tendency towards significance at the 10% level is observed concerning ICT skills for teaching, where the perceived need among teachers of other subjects is greater than that of mathematics teachers. The statistical details of this comparison are illustrated in Table 3.

Table 2. Comparison of perceived needs for professional development courses between the types of mathematics teachers.

Perceived Need for Professional Development Courses	Anova	Types (Mathematics Teachers)		
		Teaching	Correcting	Socially Interacting
(a) in teaching equity and diversity	$F(2, 802) = 3.184$; $p = 0.04$		> higher perceived need for training in correcting type than socially interacting type (difference = −0.29; $p = 0.049$)	
(b) in teaching students with special needs	$F(2, 818) = 2.5350$; $p = 0.08$	< lower perceived need for training in teaching type than correcting type (difference = −0.25; $p = 0.07$)		
(c) in teaching in a multicultural and multilingual setting	$F(2, 880.8) = 2.502$; $p = 0.08$	< lower perceived need for training in teaching type than correcting type (difference = −0.26; $p = 0.08$)		
(d) in the use of evaluation results	$F(2, 803) = 2.413$; $p = 0.09$		> higher perceived need for training in correcting type than socially interacting type (difference = −0.24; $p = 0.08$).	

Table 3. Comparison of perceived training needs between mathematics and other subject teachers.

Perceived Need for Professional Development Courses	*t*-Test	Compared Groups of Teachers	
		Other Subjects	Mathematics
(e) in second language teaching	$t(1628.9) = -2.9793$; $p < 0.01$, $d = -0.13$	> higher perceived training need for group of other teachers than for group of mathematics teachers	
(f) in knowledge and understanding of the related subject field(s)	$t(1755.8) = -3.6506$; $p < 0.001$; $d = -0.15$	> higher perceived training need for group of other teachers, both means relatively low, so the need in general is not that high	
(g) in ICT skills for teaching	$t(1672.4) = -1.7800$; $p = 0.07$; $d = -0.08$	> tendency to a higher perceived need for group of other teachers than for the group of mathematics teachers	

With respect to cooperative work, all analyses indicate no significant differences among the three activity types of mathematics teachers, nor between the mathematics group and teachers from other subjects. An inspection of the reading and non-reading subgroups of mathematics teachers reveals a tendency at the 10% significance level for participation in a teacher network specifically formed for professional development, as indicated by Fisher's Exact Test ($p = 0.08$, $V = 0.12$). Among reading mathematics teachers, participation in such a network is over 10% more likely than non-participation, whereas non-reading mathematics teachers show a higher likelihood of non-participation. When comparing the three activity types in terms of time invested, there are no significant differences in participation within a teacher network, engagement in individual or collaborative research on topics of interest, or involvement in informal dialogues with colleagues aimed at enhancing teaching practices.

Regarding job satisfaction, there are no significant differences among the three activity types of mathematics teachers. However, a tendency at the 10% level of significance is observed concerning satisfaction with their own perceived performance at their respective schools ($F(2,811) = 2.755$; $p = 0.064$), with teaching-focused mathematics teachers reporting higher satisfaction than those categorized as socially interacting. This item also

reveals a tendency at the 10% significance level, with the reading subgroup of mathematics teachers reporting higher satisfaction than those who do not read work-related literature ($t(88.591) = 1.8255$, $p = 0.071$).

In contrast, when comparing mathematics teachers with teachers of other subjects, distinct effects emerge. Specifically, there is a significant difference in agreement with the statement regarding a desire to choose the teaching profession again ($t(1721) = 3.3443$; $p < 0.001$), with mathematics teachers showing a greater inclination to reaffirm their choice of profession ($m = 3.25$) compared to teachers in other subjects ($m = 3.13$). However, the effect size is small ($d = 0.14$). This item does not reveal any differences between the reading and non-reading subgroups of mathematics teachers. Furthermore, the teachers' perceptions regarding whether the teaching profession is valued in society vary, with the reading subgroup of mathematics teachers reporting a higher valuation in society ($m = 2.09$) than the non-reading subgroup ($m = 1.85$) according the significant two sampled Welch-test ($t(99.659) = 2.0575$, $p < 0.05$), with a small effect size ($g = 0.31$). When comparing this item for mathematics teachers with teachers from other subjects, only a tendency at the 10% level of significance shows up ($p = 0.078$), with Cohen's $d = 0.07$ and a mean difference of 0.07; however, this finding should not be overinterpreted. Another tendency at the 10% significance level emerges for the item assessing enjoyment of working at the respective school ($t(91.63) = 1.6843$, $p = 0.096$), with the reading subgroup of mathematics teachers reporting higher enjoyment ($m = 3.17$) compared to those who do not read work-related literature ($m = 2.98$).

In the analysis of mental health, the weighted likelihood estimates (WLEs) provided in the PISA dataset are utilized. These values are derived from appropriately recorded scales, resulting in means that are z-standardized, ranging from negative infinity to positive infinity. The investigation of mental health focuses on several relevant factors, including perceived sources of stress, teachers' work autonomy, teachers' work overload, and teachers' affect. When comparing the means across different types of mathematics teachers' activities, only teachers' work overload reveals a significant mean difference ($F(2, 797) = 9.687$; $p < 0.001$). The application of Tukey's post-hoc test (Figure 3) offers additional insights, indicating that the teaching type experiences significantly less work overload compared to the other mathematics teacher activity types. No significant mean difference is observed between the socially interacting and correcting types. Given the expected nature of this effect, it underscores the necessity for support for teachers who invest more time in additional responsibilities.

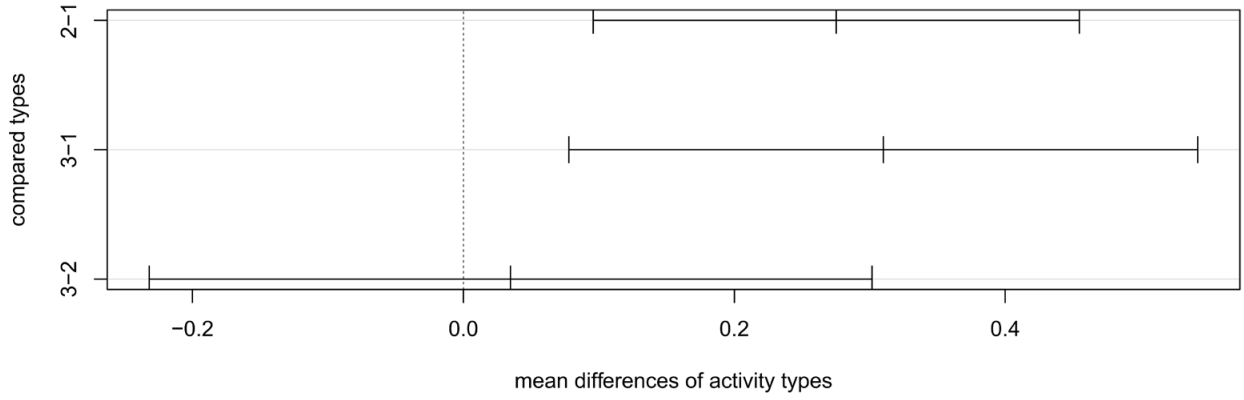


Figure 3. 95% confidence interval of Tukey post-hoc test to compare the mathematics activity types (compared types: (1) teaching; (2) correcting; (3) socially interacting) in terms of work overload.

In contrast, there is neither a significant mean difference in work overload between the overall group of mathematics teachers and the group of teachers from other subjects nor between the subgroups of reading and non-reading mathematics teachers. However, when examining other variables related to mental health, significant mean differences emerge

for affect ($t(1572.1) = 2.77$; $p < 0.001$; d = 0.12; $m_{maths} = -0.24$; $m_{other} = -0.34$) and sources of stress ($t(1638.8) = -3.06$; $p < 0.001$; $d = -0.13$; $m_{maths} = 0.20$; $m_{other} = 0.29$). Inspection of the reading and non-reading subgroups of mathematics teachers reveals significant differences in the sources of stress ($t(110.07) = -2.4321$; $p < 0.05$), with significantly fewer perceived sources of stress among the reading subgroup ($m = 0.16$) than among mathematics teachers who do not deal with work-related literature ($m = 0.40$). In contrast, there is only a tendency for teachers' affect when comparing the reading and non-reading subgroups ($t(100.42) = 1.8514$; $p = 0.067$), with a less negative affect among the reading mathematics teachers ($m = -0.23$) than among mathematics teachers not reading work-related literature ($m = -0.44$).

A tendency towards significance at the 10% level is observed for teachers' work autonomy ($t(1658.1) = -1.6484$; $p < 0.10$; d = −0.07; $m_{maths} = -0.27$; $m_{other} = -0.22$), while there are no differences between reading and non-reading mathematics teachers. However, this effect is really small and should not be overinterpreted.

4. Discussion

4.1. Three Different Types of Mathematics Teachers Based on the Time Invested in Everyday Teaching

An important prerequisite for engaging with work-related literature is the opportunity to allocate time for it. Therefore, before examining the reading of work-related literature itself, it is essential to gain insight into how teachers allocate their working time across different tasks. Based on the time devoted to various work tasks in daily school life, we can identify three distinct types of mathematics teachers in Germany. We focus on mathematics teachers in Germany, comparing them to teachers of other subjects, in order to concentrate on region-specific variations within a single country and avoid confounding effects due to cultural differences that we would allegedly find in cross-country comparisons. This approach aims to identify subject-specific differences related to mathematics, providing a foundation for further investigations into this topic. According to our analyses, mathematics teachers in Germany can be divided into the following three activity groups: Teaching, Correcting, and Socially Interacting. The teaching type is the most prevalent activity type, comprising more than two-thirds of mathematics teachers, while the correcting type accounts for slightly over ten percent. The remaining fifth of mathematics teachers are categorized as socially interacting types. Other studies examining the diverse tasks of teachers in Germany and the corresponding working hours identify several fields of activity, typically seven or eight [43,44]. These fields of activity align with the tasks defined for teachers by the Conference of Ministers of Education and Cultural Affairs, which include teaching, educating, assessing, counseling, further development of their own skills, and enhancing their own school [43]. Notably, the largest proportion of time invested is in teaching and teaching-related activities, followed by approximately 9% of the working time dedicated to communication [44].

Another study examining the working hours of German teachers does not cluster the teachers but categorizes their activities into groups that closely resemble our identified activity types [45]. Each activity type, with its distinct focus, allocates the majority of time to teaching itself, followed by lesson planning and preparation. Notably, the teaching type dedicates significantly more time to these two tasks compared to the socially interacting and correcting types. The teaching type allocates nearly half of its working hours to direct teaching, while the other two types each spend approximately one-third of their working time in a manner consistent with the legally or contractually stipulated working hours for German upper secondary education [46]. While the teaching type devotes over 70% of its overall weekly working hours to teaching and lesson planning, mathematics teachers categorized as correcting types invest more than three times as many hours in marking and correcting student work than their counterparts in the other two types. Furthermore, the socially interacting type spends considerably more time on a variety of tasks compared to the mathematics teachers in the other activity types, including teamwork and dialogue,

student counseling, general administrative duties, and communication and collaboration with parents or guardians. Additionally, the socially interacting type is notably more engaged in extracurricular activities.

Our analysis reveals minimal to non-existent correlations between the weekly working hours dedicated to teaching, teaching-related activities, and other tasks, indicating that additional working hours do not depend on teaching hours [45]. Significant differences were found in the total time allocated per activity type, with mean value differences of up to 12.31 h per week, focusing solely on full-time teachers. In contrast to previous observations that differences in working hours between those working less than 40 h per week and those exceeding 45 h arise mainly from teaching-related activities [45], our analysis attributes the difference primarily to correcting and socially interacting activities. Nevertheless, all three types of teachers average more than 40 h each week.

We can address the second research question by identifying three distinct types of mathematics teachers who not only work different hours weekly but also allocate their time differently among various tasks. This finding aligns with existing research, indicating considerable variability in the working hours and workloads of German teachers [47].

These three activity types were not observed among teachers of other subjects, suggesting subject-specific differences in time allocation, which therefore does not appear to be generalizable to teachers. Consequently, subject-specific time allocations should be considered for teachers engaged in additional responsibilities like professional development. Our analysis focused solely on mathematics, as the PISA 2022 teacher questionnaire does not ask which other subjects are taught, and the significance of activity fields vary across subjects.

Given that high-examination subjects, such as mathematics, German, and foreign languages, require greater correction effort [43], the correcting type may particularly reflect a characteristic of teachers in these disciplines. Additionally, class teachers need more time for organizational, administrative, educational, and advisory tasks [43], which are primarily undertaken by the socially interacting type. As mathematics is a core subject with multiple lessons allocated weekly, mathematics teachers may also function as class teachers, influencing the activity types related to the subject matter.

An important limitation is that the analyzed data do not specify which subjects are taught alongside mathematics, potentially contributing to unknown variance. Comparing subject combinations, teachers who exclusively teach languages report the longest weekly working hours, followed by those with profiles in the natural or social sciences [45].

Future studies should also explore the effects of gender and age on weekly working hours, as younger colleagues and female teachers tend to require more time. This gender effect may relate to the type of school, particularly within the primary sector [45]. It is important to note that the time allocated per task is based on self-assessment by teachers, which may be influenced by individual differences in perception.

4.2. Implications of Reading Work-Related Literature

Previous investigation, leading to three types of time allocation in German mathematics teachers, allows us to link the reading of work-related literature with the variable time, which is often cited as a major resource-related challenge for professional development, e.g., [17,34–36,42]. Moreover, this enabled us to examine the reading of work-related literature among teachers in the context of their daily workloads.

First, we observed a significant difference in reading work-related literature between mathematics teachers and their counterparts in other subjects; mathematics teachers reported lower engagement in this activity over the past year. This finding contrasts the expectations following the assumption that more subject-specific work-related literature is available for mathematics because of its pioneering role in studies on professional content knowledge [11–13,15] and the great appreciation of mathematics teachers in PISA 2012 for evidence-oriented practices [36]. This discrepancy raises questions about the presumed subject-specific affinity for research, particularly given the negative attitudes

identified in earlier studies, e.g., [48–50]. Without specifying the type of literature, neither a broader range of work-related literature seems more likely to be used, nor does the anticipated closeness to research among mathematics teachers appear to hold. Future research should explore the impact of mathematics as a subject on teachers' engagement with academic literature.

Second, our findings on reading work-related literature reveal that the socially interacting type of mathematics teachers is most engaged in this measure of professional development, despite their higher level of commitment to various activities next to teaching and correcting. Compared to the other two activity types, it could be plausibly concluded that those who already distribute their working time across various aspects of their job are also able to fit in reading work-related literature. This indicates that social and networking elements may positively influence professional development engagement. Previous research has shown that evidence transfer into school practice is facilitated through collaborative discussions, and higher cooperation levels correlate with a greater orientation towards evidence in practice [33]. Teachers' interactions significantly impact their actual use of evidence as a resource [51]. Given the international emphasis on social networking in teaching, further research could investigate whether the trend of increased reading among socially engaged teachers is evident elsewhere. Despite managing numerous tasks, including extracurricular activities, socially engaged teachers demonstrate a strong willingness to engage with work-related literature, suggesting that informal learning opportunities are particularly appealing to them.

Approximately three-quarters of teaching-focused mathematics teachers engage with such literature—16% fewer than their socially interacting counterparts. This is notable given that time constraints are often cited as a barrier to reading work-related literature, e.g., [17,34–36,42], yet the teaching-focused type reports the lowest overall time investment (see Table 1). The least committed to reading work-related literature are the correcting-type mathematics teachers, with only two-thirds engaging in this activity. This lower commitment may reflect the time demands of correction tasks, possibly exacerbated by correction-intensive second subjects. To sustain professionalism amid the teacher shortage [28] and more broadly, it is crucial to develop strategies that reduce the burden on correcting teachers and/or sensitize teaching-focused teachers to the relevance of engaging with work-related literature.

Reading work-related literature, supported by the growing availability of open educational materials, could offer an opportunity for professional development outside traditional courses, allowing for more individualized learning tailored to teachers' time management and interests. In light of the teacher shortage, the ability for independent study of scientific findings represents a significant advantage for lifelong professional growth. Third, although the impact of reading work-related literature on critical thinking skills is modest, it remains significant. Critical thinking is essential for interdisciplinary competencies, such as education for sustainable development and media literacy, as for example outlined in the Baden–Wuerttemberg education plan [52]. Understanding this connection could shed light on whether teachers adopt evidence-oriented practices more effectively through reading or whether the literature itself fosters critical thinking skills.

In summary, we can address our first research question by noting that mathematics teachers differ from teachers of other subjects in their reading of work-related literature. Additionally, participation levels vary among mathematics teachers based on their activity type, with the socially interacting type demonstrating the highest engagement in reading and the correcting type demonstrating the lowest—answering the second part of our second research question.

4.3. Slight Deviations in the Perception of Resources and Needs

In addition to analyzing the working hours of German teachers, we examined other resources and needs reported in PISA 2022. Our findings indicate that while there are no significant differences in job satisfaction among different activity types, teaching-type

teachers tend to report higher satisfaction regarding their performance compared to those focused on social interactions. Mathematics teachers also exhibit a slight tendency to prefer their profession over teachers of other subjects. However, when examining job satisfaction among mathematics teachers based on whether they read work-related literature, significant differences emerge. These differences indicate that reading mathematics teachers perceive the teaching profession as more highly valued in society and report greater satisfaction with their own performance and enjoyment of working at their respective schools. These factors, associated with higher job satisfaction among reading teachers, underscore the importance of professional development initiatives for professional success and job satisfaction [26]. The overall small and often insignificant differences may stem from a generally high level of job satisfaction, as reflected in the German School Barometer [23].

Despite this overall high job satisfaction, the extra workload teachers face can jeopardize their physical and mental health, particularly when peak workloads limit recovery time [47]. Teachers working over 45 h per week experience greater emotional exhaustion than those working fewer than 40 h [45]. Notably, mathematics teachers of the teaching type report feeling less overloaded compared to their peers of the socially interacting and correcting type, likely due to the heavier administrative burdens and interactions that other types face [53]. While differences in work overload were observed among activity types, no significant differences were found between mathematics teachers and teachers of other subjects, nor between reading and non-reading mathematics teachers. Thus, work overload appears to be more a consequence of the organization of working hours than of subject-specific demands or engagement in professional development.

The high expectations of the teaching profession contribute to excessive demands, often leading to stress and a diminished sense of well-being [54]. Teacher absences due to sick leave further exacerbate the workload of remaining staff [27,53]. While longer hours are associated with increased stress and burnout, correlations between working hours, recovery, and emotional exhaustion are weak, indicating that perceived stress factors extend beyond mere time commitments [45,47]. Our analysis found no differences among mathematics activity types regarding perceived stress, work autonomy, or emotional affect. Comparisons with other subject teachers revealed significant differences, with mathematics teachers experiencing less impact on emotional well-being and stress. Focusing again on the reading and non-reading subgroups of mathematics teachers, significantly fewer sources of stress and tendentially lower impact on teachers' affect are observed among those reading work-related literature. This may support the finding that individual stress can increase when personal standards are unattainable [30], as reading teachers may use this activity to achieve personal standards. Overall, this provides an interesting indication that the time spent reading professional literature may contribute positively to teachers' well-being.

Critical resources for teacher well-being include the quality of support and cooperation with colleagues, regardless of the frequency or type of collaboration [23]. Our analysis of cooperation among mathematics teachers' activity types found no significant differences in participation in teacher networks, individual or collaborative research, or informal dialogues about teaching improvement. Interestingly, despite a self-reported emphasis on social interaction, this did not translate into greater engagement in cooperative professional development activities. Furthermore, although social interactions can motivate professional development participation [21], those who spend considerable time on social tasks do not necessarily engage more in interactive development formats. This may reflect a broader cultural distinction, as German teachers reportedly engage less in collaborative practices than their international counterparts, with only half of German teachers participating in collaborative observations compared to 41% of their peers globally [22,23]. Certainly, the comparison of reading and non-reading mathematics teachers reflects a trend towards reading teachers being more likely to be engaged in a network formed specifically for professional development than not being engaged in one of those. This trend should be analyzed in more detail in further studies.

While there is a generally uniform demand for interactive professional development, differences emerge in perceived training needs across mathematics teachers' activity types. Notably, the correcting type expresses a higher need for courses focused on teaching equity and diversity compared to the socially interacting type. They also indicate a greater need for training in using evaluation results and for teaching students with special needs or in multicultural settings than the teaching type. Overall, the correcting type, which invests significant working time, exhibits higher perceived training needs, particularly related to classroom diversity. In contrast, mathematics teachers demonstrate lower needs for second-language training compared to teachers of other subjects, who also report a greater need for subject-specific knowledge and ICT skills for teaching. Despite these differences, the overall low demand for professional development is noteworthy in both groups, which may also explain the lack of differences in perceived training needs between reading and non-reading mathematics teachers. The results presented here address our third research question concerning differences in mental health, job satisfaction, cooperation, training needs, and the respective role of engagement in reading work-related literature.

4.4. Conclusions for Educational Monitoring and for Policy and Practice

Overall, this paper provides insights from the PISA 2022 data on how working time is allocated and how it relates to engagement in reading work-related literature among mathematics teachers, revealing a more homogeneous group compared to the overall sample due to their shared subject focus. Our analyses of the resources and needs of mathematics teachers, as compared to other subject teachers and differentiated by the three identified activity types, yield a comprehensive understanding of professional development challenges. Although numerous resource-related, knowledge-related, or practice-related variables affect teachers' professional growth [42], we specifically linked all three challenge categories for mathematics teachers to reading work-related literature. Based on these findings, we advocate for maintaining a broad perspective on challenges for further analyses before narrowing down the target group.

From our discussion, we derive the following theses, which we believe are useful for monitoring professional development activities as measures for evidence-oriented teaching in school practice:

1. The amount of time teachers dedicate to specific activities within a subject group varies significantly. Viewing teachers as a homogeneous group may not be productive. There is a need for a systematic analysis of teachers' tasks, as proposed by the SWK [28], focusing on how much time teachers allocate to these activities within certain subjects (or subject groups). This approach can help identify common challenges and inconsistencies that teachers face, facilitating their integration into a professional understanding [54]. Furthermore, systematizing teachers' tasks by subject could serve as a crucial foundation for educational research to identify and appropriately address target groups with generated evidence.
2. Social and networking aspects are notable in professional development contexts. While the potential for social interaction encourages participation in professional development [21], the social climate within schools also impacts professional development [33,51]. Our findings underscore the role of social interaction in fostering a willingness to engage in professional development, although they do not indicate a significant impact on participation in interactive formats. Future research should explore how the social and networking dimensions among various teacher groups affect their engagement with specialized literature, evidence, and research.
3. Our findings regarding the varying sources of stress and teachers' affect, depending on whether they read work-related literature, suggest that promoting teachers' mental health through professional development measures is beneficial. Additionally, work overload varies among teachers based on how they allocate their working time across different tasks. Further research should explore the connection between mental health factors and engagement in professional development, as this could serve as a long-

term strategy to support teachers during periods of teacher shortages and increased professional demands, in contrast to the limited short-term solutions currently in place [27].

4. The current discourse on evidence-oriented teaching calls for teachers to prioritize scientific findings. Such demands should be grounded in monitoring the current willingness and implementation of evidence-oriented practices. This necessitates covering various relevant aspects of evidence-orientation through items or scales in major comparative educational studies. Notably, the PISA 2022 data do not include variables for the explicit measurement of evidence-oriented practice. Therefore, we considered reading work-related literature as an indicator of a willingness to engage with this approach. This raises questions about whether evidence-oriented teaching can be inferred from reading work-related literature, as well as the type of literature the examined teachers are referring to. However, the term 'work-related literature' remains ambiguous, and the PISA 2022 data do not allow for an analysis of attitudes towards evidence-oriented teaching. Nonetheless, our findings provide valuable insights for further investigation. In addition to the scale on attitudes towards evidence-oriented teaching used in a national enhancement in Germany PISA 2012, and omitted in 2022, Georgiou and coauthors [41] have developed and validated scales for such assessments in English and German. Since the PISA data do not contain any variables for the explicit recording of evidence-oriented practice, it should be discussed with a view to more in-depth studies on whether or not these should be included for a comparison between several education systems.
5. The only significant correlation between self-assessed skills and reading work-related literature pertains to supporting students' critical thinking skills. The higher effect observed among mathematics teachers suggests subject-specific influences on this relationship. Understanding the significance of this connection, its direction, and underlying factors could provide valuable insights into the skills fostered by reading work-related literature.

In conclusion, we suggest that tasks, subject-specific socializations, characteristics, competencies, and attitudes should not be viewed as isolated factors but rather in combination. Clustering these combinations based on challenge categories [42] could facilitate subsequent systematic overviews. In the next step, these combinations can be analyzed concerning readiness for professional development and engagement with evidence and research, exploring what factors may encourage this engagement.

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