Teachers’ Attitudes toward Interdisciplinary Integration: A Comparative Study of Mathematics with Physical Education and Science[**]

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ABSTRACT

Interdisciplinary and integrated teaching approaches, particularly within the STEAM framework, have been increasingly recognized as effective ways to enhance students’ conceptual understanding, motivation, and engagement, as well as to support physically active learning in primary education when integrated with Physical Education. Given the central role of teachers in implementing such approaches, it is important to examine their attitudes and teaching practices related to interdisciplinary integration. The aim of this study was to investigate primary school teachers’ attitudes toward the integration of Physical Education (PE) and science content into mathematics classes, as well as the practices they currently implement. The research was conducted on a sample of 263 primary school teachers in Serbia using a questionnaire consisting of two attitude scales and four closed-ended questions. The results indicate that the majority of teachers reported having integrated both PE and science content into mathematics classes at least once, with interdisciplinary integration implemented, on average, in approximately one quarter of mathematics lessons. Teachers expressed generally positive attitudes toward both forms of integration, with more favorable attitudes toward science–mathematics integration. Educational level was found to be a significant factor influencing attitudes toward PE–mathematics integration, whereas years of work experience did not significantly affect attitudes toward either PE–mathematics or science–mathematics integration. The findings highlight the importance of strengthening initial teacher education and professional development programs to better support interdisciplinary and integrated teaching practices in primary education.

Keywords: *interdisciplinary teaching, STEAM education, Physical Education and mathematics integration, science and mathematics integration, primary school teachers.*

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Introduction

In modern educational research and practice, there is a growing need for interdisciplinary and integrated teaching approaches, particularly in elementary education. Integration in the classroom involves designing learning experiences that combine and connect traditional subject boundaries, allowing students to engage with content in a more holistic way (Darling-Hammond et al., 2020; Ignjatović & Miloradović, 2018; Pavlović & Cicović-Sarajlić, 2013). This is especially relevant in the early years of schooling, as the primary school years represent a period when students develop self-belief in their abilities as STEM learners. Students' experiences during primary and early secondary education play a crucial role in shaping their sense of competence in fundamental mathematics and science concepts, which can foster interest in pursuing science-related fields (Ainley et al., 2008). Additionally, early childhood is an ideal time for establishing healthy lifestyle habits related to regular physical activity (Expert Panel on Integrated Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents, 2011).

Interdisciplinary education in primary schools, particularly the integration of mathematics and physical education, offers a promising approach to enhancing both cognitive and motor development in children. Traditional education has often positioned students in a passive and sedentary role, limiting opportunities for physical movement. However, a growing body of research highlights the strong relationship between movement and cognition in primary and secondary school students, as well as the cognitive benefits associated with physical activity (Doherty & Miravalles, 2019). By combining logical–mathematical tasks with physical activity, students engage in experiential learning that reinforces mathematical concepts through movement and embodied interaction (Ignjatović & Miloradović, 2018, 2024). Research shows that such approaches improve students' understanding of mathematics while simultaneously increasing their physical activity levels and classroom engagement (Cecchini & Carriedo, 2020). Moreover, a recent systematic review published in *Uzdanica* highlights that the use of logical–mathematical games in physical education supports both academic and motor outcomes in young learners (Miloradović et al., 2024). Finally, a recent meta-analysis (Lau et al., 2026) evaluating interdisciplinary research in STEAM and physical education found that the largest number of studies focused on the integration of physical education and mathematics. Mathematics is often integrated with physical education because many motor activities naturally involve counting, measuring, and comparing, allowing for the direct application of mathematical concepts through movement. Additionally, kinesthetic learning enhances understanding of abstract ideas, making this combination a common focus in research aimed at supporting both academic and physical development. These findings confirm that mathematics is the most commonly and effectively connected subject to physical education within the STEAM framework. Out of the 44 studies included in the analysis, 19 examined the relationship between physical education and mathematics, underscoring the value of integrated physical education and mathematics curricula in fostering deeper learning in primary education (Lau et al., 2026).

The integration of science into mathematics teaching is particularly important because it enables students to view mathematical concepts within functional and empirical contexts, thereby reducing abstraction and enhancing understanding through application. There are multiple reasons for integrating scientific content into mathematics instruction. First, mathematics and the natural sciences are complementary disciplines that rely on shared processes such as logical reasoning, measurement, experimentation, and data analysis. Integrated teaching encourages students to understand how mathematical models describe phenomena in nature (Ainley et al., 2008), contributing to the development of STEM competencies from an early age.

Another important reason relates to student motivation and engagement. Through research-based and experimental activities, students actively participate in learning, connect abstract concepts with real-life situations, and develop a deeper understanding of ideas (Cecchini & Carriedo, 2020). In this way, mathematics ceases to be a purely theoretical discipline and becomes a tool for exploring and explaining natural phenomena. A third reason lies in the development of lasting and functional knowledge. An integrated approach contributes to improved content retention, as students learn through multiple modalities–visual, practical, and cognitive. As noted by Ignjatovic and Miloradovic (2024), experiential learning through interaction with the environment leads to more stable conceptual understanding and its long-term application.

Numerous studies confirm that integrating science into mathematics instruction yields significant pedagogical and developmental benefits (Džinović, 2017). Above all, it fosters higher-order cognitive abilities such as analytical thinking, problem-solving, and knowledge transfer across domains. It has also been observed that interdisciplinary teaching models increase students’ interest in STEM fields, particularly at the elementary level, when attitudes toward science and mathematics are still being formed (Ainley et al., 2008).

In addition to cognitive benefits, integration provides affective advantages, including increased motivation, more positive emotions toward learning, and a stronger perception of success. Martin and Murtagh (2017) reported that teachers who integrate movement and scientific inquiry activities into mathematics lessons observe greater student satisfaction and engagement, along with strengthened teamwork and self-confidence.

These findings reflect global trends in the literature emphasizing interdisciplinary approaches in STEM education (Lau et al., 2026; Li et al., 2019). Teachers most frequently highlight that integrating scientific content supports a better understanding of mathematical concepts and the acquisition of lasting, applicable knowledge. This aligns with integrated learning models that promote the practical application of mathematical skills through scientific experiments, measurement, and data analysis. Integrating science into mathematics teaching not only supports understanding and application of mathematical concepts but also fosters students' research orientation, creativity, and critical thinking. It enables a shift from traditional, subject-isolated teaching toward dynamic, experiential learning that connects theory and practice. While teachers recognize the pedagogical potential of integrated approaches, they also emphasize the need for further professional development and institutional support to ensure consistent and effective implementation in educational practice.

Despite strong theoretical and empirical support for interdisciplinary teaching, teachers' classroom practices vary considerably. Research conducted with in-service primary school teachers in Serbia (Milanović & Maksimović, 2021) showed that 55.7% primarily use a traditional, teacher-centred lecture style (*ex cathedra*). While effective for content delivery, this approach often isolates subjects and does not support the development of interdisciplinary thinking or the creative skills needed to solve complex problems in contemporary society. Most of the situations and problems students encounter today are very complex, rarely having only one exact solution, thus requiring knowledge of multiple disciplines (OECD, 2018). If we take into account the continuous expansion of knowledge in a rapidly changing modern society, in some domains knowledge becomes outdated relatively quickly, whereas in others, such as mathematics, core concepts remain stable, but the ways in which they are applied and the contexts in which they are used change. In this sense, the path to knowledge becomes just as important as the knowledge that students acquire (Đorđević et al., 2020).

Building on this, it is important to investigate how teachers perceive interdisciplinary teaching, particularly the integration of physical education with mathematics and science. There is a scarcity of studies examining teachers' use of physical activities in the classroom and the benefits they perceive for students' learning and behavior (Gilmore et al., 2024). Existing studies are often limited by small sample sizes and suggest that teachers observe several positive effects of classroom physical activities, including increased student focus (Gadais et al., 2020), greater variety and enjoyment in lessons (Lerum et al., 2021), and improved academic and behavioral outcomes (Warehime et al., 2019).

Although integrating STEM into physical education is gaining attention, a cross-sectional survey of 165 primary and secondary PE teachers in Hong Kong found that only 19.4% reported sometimes or often integrating STEM education into their teaching; nevertheless, positive attitudes, supportive norms, and a sense of control robustly predicted their intention to adopt such lessons (Li et al., 2019). Similarly, a qualitative evaluation of the Active Classrooms programme in Irish primary schools (Martin & Murtagh, 2017) provides a complementary perspective: following training aimed at embedding movement into mathematics lessons, teachers reported high satisfaction and observed greater pupil engagement, while also identifying time and resource constraints as key barriers.

Building on the findings of previous research and the identified lack of studies in this area, this study included a larger sample of teachers and a broader set of variables, with the aim of examining the extent to which integration is applied in teaching practice, as well as teachers' attitudes towards linking mathematics with physical education and natural sciences, and differences in relation to teaching experience and level of education. To build on previous findings and address existing gaps, the present study involved a larger sample of teachers and a broader set of variables in order to examine the extent of integration and attitudes toward combining mathematics with physical education and science, as well as to explore differences based on teachers' work experience and educational level.

Method

Research aim

The aim of the research was to investigate primary teachers' attitudes and perceptions regarding the integration of Physical Education (PE) and science content into mathematics classes, with a particular focus on comparing these two forms of integration.

Based on the aim of the research, the following research questions were determined:

1. To determine whether primary teachers integrate PE and science content in mathematics classes

2. To examine teachers' attitudes toward the integration of PE in mathematics classes.

3. To examine teachers' attitudes toward the integration of science content in mathematics classes.

4. To determine whether there are differences in teachers' attitudes and the extent of integration implementation in relation to their teaching experience and level of education.

Sample

The research was carried out in 2023. The research sample included a total of 263 primary teachers from primary schools in the Republic of Serbia.

Data were collected using a survey questionnaire distributed electronically (online form).

Participation in the study was voluntary and anonymous, and the sample was formed as a convenience (non-probability) sample. All participants were classified into categories based on their work experience and educational level. The structure of the sample is given in Table 1.

Table 1
Structure of the sample in regard to years of work experience (WE) and educational level (EL)

	Years of Work Experience (WE)				Educational Level (EL)		
Years	0–12	13–24	25–	Education	College	BA	MA
Frequency	113	75	75	Frequency	24	115	124
Percent	43.0	28.5	28.5	Percent	9.1	43.7	47.1

Instruments

The instrument used was a questionnaire consisting of three parts. In the first part, background information about teachers was collected (work experience, educational level, and school location). The second part included four closed-ended questions about the frequency of integrating PE and science content in mathematics classes, with responses provided through predefined frequency categories (e.g. never, rarely, sometimes, often, always). The third part contained two scales: the *Attitudes toward Integration of PE in Mathematics Classes Scale* (APEM) and the *Attitudes toward Integration of Science in Mathematics Classes Scale* (ASM). The APEM scale contained eight five-point Likert-type items (Table 2), and the ASM scale consisted of five five-point Likert-type items (Table 3). A five-point Likert scale was used to assess attitudes (1 – strongly disagree, 2 – mostly disagree, 3 – neutral, 4 – mostly agree, 5 – strongly agree). Both scales were developed by the authors, and the items were constructed in accordance with the results and implications of previous studies and literature (Cecchini & Carriedo, 2020; Đorđević et al., 2020; Ignjatović & Miloradović, 2018, 2024; Lau et al., 2026; Martin & Murtagh, 2017).

Table 2
Attitudes toward Integration of PE in Mathematics Classes Scale (APEM) items

Item codes	Item
PM1*	Physical activity during a mathematics class would only distract students.
PM2*	Physical activity during a mathematics class would lead to poor discipline.
PM3*	A student must stay still in order to be able to think during a mathematics class.
PM4*	Physical activity during a mathematics class would take up too much time.
PM5*	PE and mathematics are completely different subjects that cannot be connected.
PM6*	There is no valid reason to connect PE content with mathematics.
PM7	Implementing physical activities in mathematics classes motivates children to learn mathematics.
PM8	Implementing physical activities in mathematics classes contributes to more lasting knowledge.

Note. Items marked with * were negatively worded and were recoded.

Negatively worded items were reverse-coded prior to calculating total scores, so that higher scores indicate more positive attitudes towards integration. The APEM scale includes a larger number of negatively worded items in order to reduce the influence of socially desirable responding, while the items in the ASM scale are formulated affirmatively and relate to the perceived possibilities of integration in teaching practice.

The reliability of the scales was assessed using the Cronbach's alpha coefficient. Both APEM scale (α = .91) and ASM scale (α = .94) showed high internal consistency.

Table 3
Attitudes toward Integration of Science in Mathematics Classes Scale (ASM) items

Item codes	Item
SM1	There are science content areas that can be meaningfully integrated with mathematics content.
SM2	Integrating science content into mathematics classes contributes to a better understanding of mathematical concepts.
SM3	Integrating science content into mathematics classes enables students to acquire more lasting knowledge.
SM4	Integrating science content into mathematics classes further motivates students to learn mathematics.
SM5	Science content in mathematics classes enables the acquisition of practically applicable knowledge.

Data processing and analysis

Descriptive statistical methods were used for data processing (mean, standard deviation, frequencies, and percentages). Appropriate inferential statistical methods were applied to examine differences in teachers' attitudes in relation to teaching experience and level of education. Statistical data analysis was performed using the SPSS software package.

Results

The first research task aimed to investigate whether primary teachers use the integration of PE and science content in mathematics classes and how frequently.

The majority of primary teachers in our sample (81.4%) stated that they had integrated PE into mathematics classes sometimes. To determine the frequency of this practice, teachers were asked to estimate the percentage of last year's mathematics classes in which they used PE content. The reported average was 22.36% (*SD* = 17.88). A slightly higher percentage (86.3%) reported having integrated science content into mathematics classes at least once. The average frequency of integration last year was 26.85% (*SD* = 19.72). These findings suggest that the interdisciplinary integration reported by teachers is not a purely marginal practice, but is implemented, on average, in approximately one quarter of mathematics lessons. This may be considered an encouraging indicator of teachers' openness to using an integrated teaching approach. The slightly higher prevalence and frequency of science–mathematics integration compared to PE–mathematics integration may indicate that teachers perceive science content as more naturally aligned with mathematics content.

To investigate attitudes toward the integration of PE and science content in mathematics classes, participants were asked to rate their agreement with items on two scales. Table 4 displays the descriptive statistics (means and standard deviations) of the individual items and general scales.

Table 4
Descriptive statistics for APEM and ASM items

	Item codes	Mean (*M*)	Standard Deviation (*SD*)
APEM	PM1*	3.71	1.29
	PM2*	3.73	1.29
	PM3*	3.32	1.40
	PM4*	3.58	1.32
	PM5*	4.21	1.20
	PM6*	4.16	1.20
	PM7	4.17	1.05
	PM8	4.05	1.05
	PM general	3.87	0.96
ASM	SM1	4.56	0.78
	SM2	4.48	0.79
	SM3	4.42	0.87
	SM4	4.45	0.80
	SM5	4.50	0.85
	SM general	4.48	0.73

A more detailed analysis of descriptive indicators reveals certain differences in the distribution of responses between the two scales. For the APEM scale, a moderate negative skewness was observed (skewness ranging from −0.26 to −1.48), along with relatively pronounced variability in responses (SD ≈ 1.04–1.40), indicating greater heterogeneity in teachers' attitudes towards the integration of physical education in mathematics teaching. The medians of most items range between 4 and 5, while the modal values are most often in the highest response category, confirming a generally positive orientation of attitudes, but with noticeable differences among respondents.

In contrast, results for the ASM scale show a more pronounced negative skewness (skewness ranging from −1.53 to −2.02) and elevated kurtosis values (2.31–4.21), indicating a high concentration of responses at the upper end of the scale. The medians of all items are 5, and the dominant share of responses falls within the "strongly agree" category, suggesting a high level of homogeneity and stability in teachers' positive attitudes towards the integration of natural science content (SON/PiD) in mathematics teaching.

Individual scores on the APEM and ASM scales were calculated as mean-item summated scores. The PM general and SM general values represent the mean of these individual scores across all participants. A mean-item summated score is obtained by dividing an individual's summated score by the number of items constituting the scale, resulting in a mean-item score for each individual that falls within the range of the response continuum options (Warmbrod, 2014).

According to Narli (2010), for the Likert average scale 1.00–1.80 indicates a very low level of agreement; 1.80–2.60, low; 2.60–3.40, moderate; 3.40–4.20, high; 4.20–5.00, very high.

The second research task was to examine primary teachers' attitudes toward the integration of PE in mathematics classes. The overall findings, presented in Table 4, suggest that teachers generally hold positive attitudes toward integrating PE content into mathematics classes (PM general: M = 3.87; SD = 0.96); however, according to Narli (2010), this result does not reach the highest level of agreement on the Likert scale.

Analysis of the individual APEM items indicated that the majority of items yielded mean values corresponding to high or very high levels of agreement (M > 3.40), suggesting broadly positive attitudes toward integrating PE into mathematics instruction. The distribution of responses further supports this finding, as the modal values for all items are most frequently in the highest response category (5), but with responses present across all categories, indicating a certain degree of variability in teachers' attitudes. These results imply that teachers largely reject the notion that physical activity distracts students (PM1), leads to poor discipline (PM2), takes too much time (PM4), or that physical education and mathematics cannot be meaningfully connected (PM5 and PM6). In addition, teachers strongly endorsed the motivational and educational benefits of physical activity in mathematics classes (PM7, PM8), which is in line with the findings of Martin and Murtagh (2017). An exception was observed for the reversed item PM3 ("A student must stay still in order to be able to think during a mathematics class"), for which teachers expressed a moderate level of agreement (M = 3.32). This lower level of agreement compared to other items may reflect the persistence of more traditional conceptions of learning and classroom behavior, even among teachers who otherwise express positive attitudes toward PE–mathematics integration.

As part of the same research task, we examined whether there was a significant difference in attitudes between teachers who had integrated PE into mathematics classes at least once and those who had never done so. As expected, teachers with prior experience of PE integration expressed significantly more positive overall attitudes compared to those without such experience (U = 2842.00; Z = −5.43; p < .01). This finding indicates an association between practical experience and more positive teacher attitudes.

The third research task focused on examining primary teachers' attitudes toward the integration of science content in mathematics classes. The results indicate that teachers expressed highly positive attitudes regarding this integration (SM general: $M = 4.48$; $SD = 0.73$). High mean values indicate a high level of agreement among respondents with the statements of the ASM scale. With regard to the individual ASM items, the values of the descriptive statistical parameters (means and standard deviations) indicate that teachers expressed a high level of agreement across all items. The results show that teachers strongly agree that science content can be meaningfully integrated with mathematics (SM1), that such integration contributes to a better understanding of mathematical concepts (SM2), supports the acquisition of more lasting knowledge (SM3), further motivates students to learn mathematics (SM4), and enables the acquisition of practically applicable knowledge (SM5).

Similarly, we examined whether there was a significant difference in attitudes between teachers who reported having integrated science content into mathematics classes at least once and those who had never done so. The results of the Mann–Whitney U test showed that teachers with such experience expressed more positive overall attitudes compared to those without experience of science–mathematics integration ($U = 3466.00$; $Z = -3.96$; $p < .01$). These results further confirm the association between experience and positive attitudes, pointing to the need to provide opportunities for gaining experience in the implementation of integrated approaches.

The fourth research task aimed to investigate whether teachers' attitudes were influenced by years of work experience (WE) and educational level (EL). The Kolmogorov–Smirnov test for normality revealed that the APEM and ASM scores were not normally distributed across the groups. Therefore, to examine possible differences in attitudes with respect to WE and EL, the Kruskal–Wallis test was used.

There were no significant differences in attitudes based on years of work experience, either overall or at the level of individual items on both scales (Table 5).

Table 5
Comparison of the APEM and ASM scores in terms of the WE

	Item codes	χ^2	df	*p*
APEM	PM1*	0.72	2	.69
	PM2*	0.52	2	.76
	PM3*	0.84	2	.65
	PM4*	3.01	2	.22
	PM5*	5.09	2	.07
	PM6*	0.37	2	.82
	PM7	2.81	2	.24
	PM8	4.28	2	.11
	PM general	2.24	2	.32
ASM	SM1	0.35	2	.83
	SM2	0.78	2	.67
	SM3	2.37	2	.30
	SM4	4.99	2	.08
	SM5	3.72	2	.15
	SM general	3.03	2	.21

These findings indicate that years of work experience do not appear to significantly influence teachers' attitudes toward the integration of physical education and science content into mathematics classes. The absence of differences across groups suggests that openness to interdisciplinary teaching may be shaped by other factors such as professional learning opportunities, personal beliefs, or instructional context. However, this assumption requires further investigation in future research.

On the other hand, results of Kruskal-Wallis test indicate that there is a statistically significant difference in attitudes about integration of PE in Mathematics classes ($\chi^2(2) = 14.46$, $p < .01$) in general, in regard to the EL (Table 6). To identify the differences among the groups, the Dunn test was performed to reveal where significant differences in the APEM scores occurred. A significant difference was observed between teachers with a College degree and those with a MA degree, as well as between teachers with a BA and those with a MA degree. Teachers with an MA degree expressed more positive attitudes toward the integration of PE in mathematics classes compared to those with a College ($p < .01$) and a BA degree ($p < .05$).

Table 6

Comparison of the APEM and ASM scores in terms of the EL

	Item codes	χ^2	df	*p*
APEM	PM1*	6.67	2	.03
	PM2*	4.68	2	.09
	PM3*	4.83	2	.08
	PM4*	9.90	2	.00
	PM5*	16.87	2	.00
	PM6*	15.02	2	.00
	PM7	12.13	2	.00
	PM8	11.28	2	.00
	PM general	14.46	2	.00
ASM	SM1	3.76	2	.15
	SM2	1.67	2	.43
	SM3	4.90	2	.08
	SM4	4.02	2	.13
	SM5	2.74	2	.25
	SM general	3.89	2	.14

Regarding individual items, statistically significant differences were found for several APEM items – PM1, PM4, PM5, PM6, PM7, and PM8 (Table 6). We performed the Dunn's post hoc test for pairwise differences. A significant difference between groups was noticed for items PM4, PM5, PM6, PM7 and PM8. Teachers with a master's degree expressed a more positive attitude compared to teachers with a College degree (PM4: $p < .05$; PM5: $p < .01$; PM6: $p < .01$; PM7: $p < .01$; PM8: $p < .01$) and compared to teachers with a BA degree (PM4: $p < .05$). Teachers with a College degree also expressed more negative attitudes then those with a BA degree for items PM5 ($p < .01$) and PM6 ($p < .05$).

Disscussion

The obtained results indicate that the interdisciplinary integration reported by teachers is not a marginal practice, but is, on average, implemented in approximately one quarter of mathematics lessons. This can be considered an encouraging indicator of teachers' openness towards the application of an integrated approach in teaching. A slightly higher prevalence and frequency of integrating natural science content (SON/PiD) with mathematics, compared to the integration of physical education and mathematics, may suggest that teachers perceive SON/PiD content as more naturally connected to mathematics.

The observed pattern is consistent with considerations presented in the introduction, according to which certain forms of interdisciplinary integration are cognitively closer to teachers, that is, more aligned with their existing pedagogical beliefs and teaching routines (Ainley et al., 2008), while others, such as the integration of physical education and mathematics, require a greater departure from traditional teaching practices (Ignjatović & Miloradović, 2018, 2024). Therefore, the greater presence of SON/PiD and mathematics integration may reflect long-established teaching traditions and practices, whereas the integration of physical education and mathematics still represents a relatively innovative pedagogical approach.

However, these findings should be interpreted within a broader context, particularly considering the differences in the nature of the subjects. Content from the field of world around us / natural and social sciences (SON/PiD) more readily allows for spontaneous and content-related integration with mathematics, whereas physical education, due to its specific organisation, goals, and predominantly motor character, offers different and often less recognised opportunities for integration with mathematical content. In this sense, differences in the prevalence of particular forms of integration cannot be viewed solely through the lens of teachers' beliefs and pedagogical routines, but also through how teachers recognise and utilise the potential of different subject areas for interdisciplinary connections.

Regarding teachers' attitudes, the results show that they are generally positive towards the integration of physical education in mathematics teaching, although they do not reach the highest level of agreement. At the same time, a certain degree of variability in responses is evident, indicating differences in teachers' perceptions. A particularly important finding relates to the statement that a student must be still in order to think, where a moderate level of agreement was observed. This may indicate the presence of more traditional conceptions of learning and classroom behaviour, even among teachers who otherwise express positive attitudes towards integration. Such findings are consistent with broader discussions in the literature highlighting deeply rooted beliefs linking cognitive activity with physical stillness (Doherty & Miravalles, 2019), which may act as a barrier to the wider implementation of physically active teaching approaches.

In contrast, the results show a very high level of agreement among teachers regarding the integration of SON/PiD content in mathematics teaching, accompanied by a high degree of homogeneity in responses. This pattern may indicate a more stable and widely accepted perception of the relevance and usefulness of this type of integration in teaching practice.

The results also show that teachers with experience in implementing integration express more positive attitudes compared to those without such experience, both in the case of physical education and SON/PiD. This finding highlights the importance of practical experience in shaping teachers' attitudes and points to the need to provide more opportunities for the application of interdisciplinary approaches in teaching.

With regard to differences related to teaching experience, the results indicate that it does not represent a significant factor in shaping teachers' attitudes towards integration. In contrast, the level of education emerged as a significant factor in the case of integrating physical education and mathematics. More positive attitudes among teachers with a master's degree may be explained by differences in initial teacher education, as more recent study programmes place greater emphasis on student-centred approaches and interdisciplinary teaching methods. In this regard, the findings of the present study are consistent with those reported by Martin & Murtagh (2017), in which teachers, following training focused on the integration of movement into teaching, expressed markedly positive attitudes toward this approach. The convergence of these findings suggests that teachers' positive perceptions are not solely the result of individual experience, but can be further strengthened through targeted professional development, which contributes to a better understanding of the pedagogical and developmental benefits of integrating physical education within the STEAM framework. This finding suggests that readiness for interdisciplinary teaching is not solely the result of experience gained in practice, but is to a large extent shaped during initial teacher education.

On the other hand, no differences were found in attitudes towards the integration of SON/PiD and mathematics in relation to the level of education. This may indicate that this form of integration is more widely accepted and less dependent on formal teacher education. Such a finding further supports the assumption that teachers perceive SON/PiD content as more naturally connected to mathematics, whereas the integration of physical education and mathematics remains a relatively new and less established approach in teaching practice.

Conclusion

Considering the numerous benefits of interdisciplinary and integrated teaching approaches, particularly within the STEAM framework, as well as the importance of increasing students' levels of physical activity, and recognizing teachers as one of the key factors influencing educational practice, it is essential to examine the current state of teachers' practices and attitudes toward integrated teaching. Accordingly, the main aim of this study was to examine primary school teachers' attitudes toward the integration of Physical Education and science content into mathematics classes, to explore whether they implement such integration in their teaching practice, and to identify factors that may influence these attitudes.

The results of the study indicate that the majority of primary school teachers in the sample reported having integrated both PE and science content into mathematics classes at least once. On average, interdisciplinary integration was implemented in approximately one quarter of mathematics lessons, which may be considered an encouraging indicator of teachers' openness to integrated teaching approaches. Overall, teachers expressed positive attitudes toward integrating both PE and science content into mathematics classes, with more favorable attitudes toward science–mathematics integration. Educational level emerged as a significant factor influencing teachers' attitudes toward PE–mathematics integration, while years of work experience did not show a significant effect on attitudes toward either PE–mathematics or science–mathematics integration. Differences in attitudes related to educational level may be attributed to the fact that more recent teacher education programmes place greater emphasis on interdisciplinary and integrative teaching approaches.

These findings highlight the importance of providing targeted professional development programmes for in-service teachers aimed at strengthening their competencies for interdisciplinary integration. In addition, the results point to the need for further modernization of teacher education curricula, particularly with regard to the integration of Physical Education and mathematics, in order to better prepare future teachers for implementing integrated and physically active learning approaches in primary education. As the present study relies on self-reported data, future research could strengthen these findings by combining teachers' self-reports with observations of classroom practice or other complementary methods.

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