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ORIGINAL ARTICLE

A Mixed-Methods Study on the Alignment of Exams Prepared by Mathematics Teachers with International Exams[1]

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Ethical Statement
First, the necessary permission was obtained from the Ministry of National Education for the study, and voluntary consent forms were obtained from the participants.

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Conflict of Interest
No conflict of interest is present in the conduction or the reporting of this study."

ABSTRACT

This study was conducted to determine mathematics teachers' knowledge levels and opinions regarding international exams and to evaluate the exam questions they prepare within the context of international exam frameworks. Accordingly, the research was carried out using mixed-methods sequential explanatory design. This study collected data through the views of 68 middle school mathematics teachers teaching eighth grade. It also involved an analysis of 1316 written exam questions produced by 20 selected teachers from this group. According to the research findings, mathematics teachers mostly heard about the PISA and TIMSS exams informally through the media. The study identified several issues concerning Türkiye's education system and philosophy, the teaching and learning of mathematics, and the competencies of mathematics teachers. Additionally, the study highlighted students' cognitive and emotional capacities concerning international exams and offered recommendations for improvement. Upon examining the exam questions prepared by mathematics teachers according to the international large-scale assessment (PISA-TIMSS) frameworks, it was found that only one teacher out of 20 asked questions close to the cognitive levels of PISA, and two teachers asked questions close to the cognitive levels of TIMSS. Additionally, most of the questions in both examinations were classified at the knowledge and recall level (Level 1) of cognitive complexity. Both the teachers' opinions and the analysis of the exams they prepared indicated that teachers' awareness and knowledge of international exams needed to be at a sufficient level. The findings revealed the need to increase the effectiveness of teachers' professional development programs regarding international examinations. Particularly, it is necessary to contribute to improving the quality of the assessment tools used by teachers and to support the development of more valid and reliable measurement tools. It also emerges as an important requirement to reorganize the content of teachers' professional development programs to ensure alignment with international standards.

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INTRODUCTION

As the interaction between the mathematical and technological worlds strengthens under new paradigms, it becomes essential to shed light on the extent to which mathematical knowledge is effectively taught in order to overcome the challenges in mathematics education.The measurement and evaluation process that helps us answer this question is the most crucial factor in directing, sustaining, accelerating, decelerating, or hindering reforms in mathematics education (Suurtamm et al., 2016). This process generates empirical evidence that researchers, educators, teachers, students, and parents can use to inform decisions aimed at improving mathematics education (Nortvedt & Buchholtz, 2018; Suurtamm et al., 2016). Consequently, mathematics teachers who integrate measurement and evaluation into their teaching are likely to engage with students' learning processes and implement more effective teaching strategies (Tucker & Stronge, 2005). The data derived from this process serves as the foundation for evidence-based educational management within the education system and serves to enhance the continuous improvement of curriculum and instructional methodologies (Fortunati & Winther, 2024).

Not only do in-class assessments but also national and international large-scale assessments employed by educational stakeholders significantly enhance the quality of mathematics instruction (Suurtamm et al., 2016). The term "washback effect" in English refers to the impact of exams on teaching practices, while in Turkish literature, it refers to the forward positive effect of exams, the reflection effect of exams, exam effect, backwash effect, or feedback effect (Kaygısız, 2023). Both national and international large-scale assessment outcomes influence classroom methodologies. Many countries utilize these results as a foundational resource for implementing educational reforms, revising curricula, or assessing educational standards (Andrews, 2004; Breakspear, 2012). Both national examinations (e.g., High School Entrance Examination) and international assessment outcomes function as pivotal drivers of educational reform and policy formulation, while simultaneously influencing systemic transformations within educational frameworks. Large-scale international mathematics assessments (e.g., TIMSS and PISA) are of particular importance and are valued for the critical insights they provide, especially now that the development of 21st century skills has become a priority (Hoang, 2024; Kell&Kell, 2014).

Despite the expectation to utilize international exam results in the classroom assessment process, these data are often interpreted inadequately and predominantly utilized for media purposes in educational contexts. Studies indicate that mathematics teachers generally lack sufficient awareness and knowledge of international exams, as evidenced by their opinions and the exams they prepare (Güler, 2021). Research suggests that enhancing mathematics teachers' knowledge and awareness of international large-scale mathematics exams during both pre-service and in-service training can significantly enhance their professional growth (Hoang, 2024; Kell & Kell, 2014). These exams not only illustrate how closely students' performance aligns with global standards but also assist teachers in adapting exam frameworks to their instructional practices. Developing exams that are compatible with international standards improves teaching in line with global benchmarks, which also fosters teachers' ongoing innovation and alignment with current educational practices. Therefore, it is necessary for mathematics teachers' classroom assessment practices to align with international exams. However, our understanding of how effectively teachers meet this expectation remains limited. It is essential to assess whether there are knowledge gaps among teachers and whether the cognitive context of their exam questions corresponds with international standards. A review of the national literature reveals the importance of understanding mathematics teachers' knowledge about the goals, content, and target grade and age ranges of international mathematics exams. Additionally, it highlights the need to improve teachers' knowledge, skills, and attitudes

regarding the assessment process (Ardahanlı, 2018; Aygünel al., 2016; Çelik et al., 2020; Karaman, 2016; Önel et al., 2020; Özcan & Delil, 2018).

In recent years, exam questions contructed by mathematics teachers have been examined from various perspectives. These questions are analyzed in relation to the curriculum (Delice et al., 2013; İpek & Özdemir, 2019; Özcan & Delil, 2018), different cognitive domain taxonomies (Aygün et al., 2016; Güler et al., 2012; İpek & Özdemir, 2019; Karaman, 2016), and internationally administered exams such as PISA (Güler, 2021). However, a review of the literature reveals that no single study has adequately addressed the teachers' knowledge levels, opinions, and alignment of their exams with international standards. This gap limits the comprehensive understanding and holistic problem-solving capabilities in mathematics education. Therefore, the findings of this study could contribute to understanding the washback effect of international exams on the exams prepared by mathematics teachers. This study could help improve teachers' knowledge of international exams and identify the necessity of in-service training programs for mathematics teachers. The study has two main focuses to address this gap. The first focus is to reveal the opinions of mathematics teachers regarding the PISA and TIMSS exams, as well as Türkiye's performance in these assessments. The second focus is to evaluate the cognitive levels of the exam questions prepared by the teachers throughout the academic year, aligning with the frameworks of PISA and TIMSS. It is essential to understand the perceptions and opinions of mathematics teachers about these exams before evaluating the alignment of their exam questions with international exams, which will facilitate a more accurate interpretation of the evaluation results. Building on these objectives, the study aims to compare the cognitive levels of exam questions prepared by mathematics teachers with those posed in internationally standardized exams (PISA and TIMSS) in Türkiye. Additionally, it seeks to determine the viewpoints of mathematics teachers regarding these international exams. To achieve these aims, the study seeks to answer the following questions:

1. What are mathematics teachers' opinions on their approach to preparing exam questions?
    a. What are the teachers' opinions on the resources they rely on when preparing exam questions?
    b. What are the teachers' opinions on the guidance provided by the curriculum when preparing exam questions?
    c. What types of questions do mathematics teachers include in their exams?
2. What are mathematics teachers' opinions on international exams?
    a. What are the teachers' opinions on their knowledge and sources of information about TIMSS and PISA?
    b. What are teachers' opinions on their need for in-service training related to TIMSS and PISA?
    c. What are the teachers' opinions on the issues and proposed solutions regarding Türkiye's performance in international exams?

METHOD

Research Design

This study employed a "sequential explanatory design" (quantitative→qualitative), which integrates both qualitative and quantitative approaches (Baki & Gökçek, 2012; Creswell, 2008). This design was chosen to initially provide an overarching

view of the research problem based on quantitative data gathered predominantly from the participant opinions. Subsequently, qualitative data was collected to further deepen understanding of these findings. Quantitative data collection involved a survey developed by the researchers, which included open-ended questions to assess teachers' perspectives on internationally administered exams in Türkiye. Qualitative data, on the other hand, was obtained through document analysis of the exams prepared by the participating teachers.

Participants

The study consists of 68 8th grade mathematics teachers at the secondary education level working in public and private schools in the central district of a province in southern Turkey. Participation was based on voluntariness, and participants were selected using convenience sampling methods (Baki & Gökçek, 2012). Permission was obtained both from the Ministry of National Education (MoNE) and the participants themselves. Opinions and suggestions regarding the research problem were first gathered from all participating mathematics teachers. For the analysis of written exam questions, a subset of 20 teachers was selected. This subset included only those who had submitted at least three of their written exams, in accordance with the predetermined criterion. The majority of the participants were female graduates from education faculties, with 16% having completed postgraduate studies (master's or doctoral degrees). Among them, 54 teachers worked in public schools, 9 in private schools, and 5 in vocational religious schools. It was noted that almost all participants had not received in-service training specifically related to PISA and TIMSS. Demographic characteristics of participants are provided in Appendix 1.

Data Collection Tools

A questionnaire was employed to ascertain the perspectives of the participants, complemented by assessment forms for their written exams and exam questions. The questionnaire employed a mixed-methods design featuring both closed-ended and open-ended questions. Closed-ended questions facilitated the comparison and statistical analysis of teachers' responses while open-ended questions provided context for those responses. The closed-ended responses (Yes/No/Not Sure) were intended to identify the level of awareness or engagement, while the open-ended questions provided deeper insights into teachers' reasoning and experiences.

The questionnaire's development process included a literature review, initial draft creation, evaluation by three experts, refinement based on expert feedback, and a pilot study involving 5 mathematics teachers. Appendix 2 contains the form for categorizing according to PISA cognitive levels while Appendix 3 includes the assessment based on TIMSS. This mixed-methods approach allowed for both quantitative and qualitative analyses, enabling a more comprehensive understanding of the phenomenon (McKim, 2017).

Data Collection Procedure and Analysis

After obtaining the necessary permissions for data collection, a questionnaire was distributed to the participants. The teachers who volunteered to participate were scheduled for interviews while ensuring minimal disruption to their teaching schedules. Schools were requested to provide all written exams administered, and each teacher was asked to submit four exams used during the academic year. However, some teachers provided incomplete sets of exam questions or declined to share them entirely. Consequently, the surveys and exam questions of 15 teachers who only shared the first and second exam questions were excluded from the analysis process. The survey included responses from 68 participants, while the written exams of 20 mathematics teachers were specifically analyzed from this group. In total,

1,316 exam questions from 71 written exams conducted throughout the year were used for evaluation.

The survey data were analyzed using Microsoft Excel 2010 software. Responses of the participants to open-ended questions were coded for analysis. Categories were formed based on similar codes, and data corresponding to each category and code were organized into tables. The findings of the study were presented through the integration of both quantitative and qualitative data. Direct quotes from teachers' statements, complemented by visuals, were included in the findings section for each category identified. Moreover, to ensure credibility and reliability, the data analysis proceeded step by step considering the research questions.After the qualitative and quantitative data were tabulated, participant confirmation was obtained from three teachers.

The analysis of written exams utilized "evaluation forms for written exam questions" developed by both researchers within the frameworks of PISA and TIMSS. Following data analysis by both researchers, reliability between the two coders was determined to be 86% for TIMSS and 87% for PISA (Miles and Huberman, 1994). All questions where coders differed in assigning cognitive levels were re-examined collaboratively until agreement was reached. Graphs were employed to present the data derived from the analyzed teacher-written exams. Additionally, the cognitive distribution of questions for both PISA 2018 and TIMSS 2019 was graphically displayed to aid in the interpretation of findings. Examples illustrating the cognitive level analysis of questions for both assessments are provided in Appendix 3.

Research Ethics

This study has been rigorously documented to ensure the quality, reliability and validity of the scientific research process. Throughout this study, which was previously submitted as a master's thesis, transparency and openness in conducting the research and sharing the data, and respect for the rights of the participants and the confidentiality of their information were respected. Ethical principles were strictly adhered to at every stage of the scientific research process, from initial planning and obtaining necessary permissions to data collection, analysis, writing and appropriate referencing. Since data were collected before 2020, ethics committee permission was obtained after the study was completed.

RESULTS AND DISCUSSION

In this study, the general approach that the participants follow in the exam preparation process was initially examined based on their opinions. In this context, teachers were asked about the sources they use when preparing exam questions. The findings are presented in Table 1:

Table 1. Sources Used by Mathematics Teachers in Preparing Exam Questions

Sources	Users		Minimal Users		Non-User	
	f	%	f	%	f	%
Textbook	60	88	7	10	1	2
Mathematics curriculum	56	82	8	12	2	3
Resource book	54	79	12	18	2	3
Questions prepared by colleagues	46	68	15	22	5	7
Education Information Network (EIN)	45	66	18	26	5	7
Questions prepared in previous years	44	65	13	19	10	15
Exams downloaded from the internet	42	62	13	19	12	18
Nationally administered exam questions	27	40	25	37	16	24
Internationally administered PISA exam questions	10	15	25	37	33	49
Internationally administered TIMSS exam questions	9	13	19	28	38	56

According to Table 1, mathematics teachers most frequently use the mathematics textbook, the mathematics curriculum, and related reference books when preparing exams. Notably, the number of teachers who use international exams as a source is low. Teachers' responses regarding how the curriculum guides them in preparing exams are presented in Table 2.

Table 2. Guidance Provided by the Mathematics Curriculum to Teachers

Response	F	%	Category	Code	f
Yes	58	85	How does it guide the teacher?	Preparing exams in line with learning objectives	25
				Providing guidance on exam preparation	16
				Deciding on the scope and content of the exam	15
				Deciding on the types of questions for the exam	2
No	9	13	Why does it not guide the teacher?	Frequent changes to the curriculum	1
				The curriculum's lack of adaptation to the surrounding environment	1
				Absence of sample questions for exams	1

As shown in Table 2, 85% of mathematics teachers reported that the curriculum guides them in preparing exam questions by helping to align exams with learning objectives, providing guidance on exam preparation, determining the exam's scope, and deciding on question types. On the other hand, 13% of participants mentioned that the curriculum does not provide adequate guidance in exam preparation due to frequent changes in the curriculum, its lack of adaptation to local contexts, the absence of sample questions, and the difficulty of questions aligned with learning objectives.

To understand the approaches mathematics teachers use when preparing exam questions, this study examined not only the resources they utilize and their use of the curriculum but also the types of questions included in the exams they create. The findings regarding the types of questions used by mathematics teachers in their exams are presented in Table 3.

Table 3. Type of Questions Used by Teachers in Their Exam

Type of Questions	Number of Written Exams	Percentage
Exams with only open-ended questions	3	% 4,2
Exams with only multiple-choice questions	36	%50,7
Mixed exams including open-ended questions (e.g., fill-in-the-blank questions, true/false questions, multiple-choice questions, and open-ended questions)	28	%39,4
Mixed exams without open-ended questions (e.g., fill-in-the-blank questions, true/false questions, and multiple-choice questions)	4	%5,7
TOTAL	71	%100

As shown in Table 3, 50% of the exams prepared by the participants included only multiple-choice questions, 39% comprised mixed-format exams with open-ended questions, 5% featured mixed-format exams without open-ended questions (including fill-in-the-blank, true/false, and multiple-choice questions), and just 4% were solely composed of open-ended questions. This indicates that mathematics teachers generally prefer multiple-choice questions when designing their exams.

After establishing mathematics teachers' approaches to preparing exam questions, their views on international assessments were also explored. Notably, since 49% of teachers reported not using PISA as a resource and 56% reported not using TIMSS.This situation raises the question of whether they are sufficiently familiar with these international assessments. Table 4 presents the mathematics teachers' responses regarding whether they have previously heard of PISA and TIMSS and from which sources they obtained this information.

Table 4. Awareness of International Assessments and Sources of Information

Category	Code	PISA		TIMSS	
		F	%	f	%
Awareness	Yes	58	85	43	63
	No	10	15	25	37
Sources of information	Media (Social, Print, and Visual Media)	36	53	22	32
	Colleagues	2	3	2	3
	Undergraduate Education	3	4	2	3
	In-Service Training	3	4	1	2
	Peers	1	2	1	2
	Own Child	1	2	-	-
	Involvement in these exams	1	2	-	-
	Reference Books	1	2	2	3
	Do not remember	1	2	1	2
	No Response	9	13	12	18

Table 4 shows that most of the participants reported their familiarity with the PISA assessment. They indicated that they primarily learned about PISA through social, visual, and print media. Furthermore, more than half of the mathematics teachers said they had also heard of the TIMSS assessment, with PISA being more frequently mentioned than TIMSS. They noted that the information they received about these assessments mostly came from informal sources, such as written press and social media, rather than formal sources like pre-service or in-service training.

The study also explored mathematics teachers' perceptions of their need for in-service training related to TIMSS and PISA assessments. Table 5 shows the codes reflecting the teachers' views on whether they feel a need for such training.

Table 5. In-Service Training Needs of Mathematics Teachers Regarding International Exams

Response	F	In-Service Training Topics	f
Yes	48	The content and scope of the exams	15
		Exam questions and question types	10
		The administration of the exams	7
		Teaching the necessary skills to students	5
		Preparing questions that target higher order thinking skills	5
		Examining the curricula of countries that perform well in these exams	1
No	11	The risk of in-service training being ineffective without changes to the curriculum	11

The mathematics teachers expressed a need for in-service training on several key topics. These include the structure and content of national exams, methods for teaching students the necessary skills for these exams, techniques for preparing questions targeting higher order thinking skills, and a comparative analysis of the curricula from countries that perform well in international exams. However, eleven participants indicated that they did not see a need for in-service training, arguing that such training would be ineffective unless the current curriculum were revised to align with international exam standards.

In examining mathematics teachers' perspectives on international exams, data were also collected regarding the reasons why Türkiye has yet to achieve the expected success in these exams and their suggestions for improvement. Upon analysis, four categories emerged: the education system and philosophy, the mathematics learning and teaching process, the competencies of mathematics teachers, and students' cognitive and affective preparedness. The codes related to these categories are presented in the tables below. These categories address both the issues related to the lack

of success and the suggestions for improvement.

The first category consists of views related to the education system and philosophy. This category includes opinions that attribute to the lack of expected success in the education system and philosophy, as well as suggestions indicating that a change in this area could lead to success. The views related to this category are presented in Table 6.

Table 6. Issues and Recommendations Related to the Educational System and Philosophy

Issues		Recommendation	
Code	**f**	**Code**	**f**
Lack of alignment between the curriculum and exams	15	Structuring the curriculum according to international exams	41
Lack of equal opportunities among schools	3	Adopting an applied education model	11
Insufficient emphasis on exams	2	Ensuring continuity in the education system	3
Constant changes in the education system	2	Improving the physical infrastructure of schools and reducing class sizes	3
Failure to involve students in the educational process	2	Establishing mathematics workshops	3
Short-term problem-solving focus	1	Providing guidance to schools	2
Overcrowded classrooms	1	Examining the curricula and strategies of successful countries	1
Schools not being treated as places of learning	1	Ensuring equal opportunities between schools	1
High content density in the curriculum	1	Increasing class hours	1
		Revising the system for grade promotion and grading	1

Table 6 demonstrates that the participants identified several reasons why Türkiye's performance in international exams does not meet expectations. These reasons include a lack of equal opportunities between schools, insufficient attention to international exams, frequent systemic changes in education, failure to involve students in the educational process, efforts to address immediate issues rather than long-term goals, overcrowded classrooms, and the perception of schools as mere places to pass time. For example, T33 highlighted that the education system is not well-aligned with international exams, while Participant T50 pointed out the constant changes within the education system.

> "*The questions asked in international exams are not closely aligned with the education provided in schools." T33 (Female, Age: 33)*

> *"The frequent changes in the education system with each new minister are seen as a major issue. The rapid shift from an education system that was previously promised with grand plans to a newly established system without sufficient preparation creates significant obstacles. Additionally, viewing schools merely as places where students pass time rather than focusing on developing their skills and abilities undermines the importance of nurturing students' talents." T50 (Female, Age: 47)*

Participants' recommendations regarding the education system and philosophy are as follows: establishing a practice-based education system, improving the physical infrastructure of schools, ensuring systematic continuity in education, analysing the education systems of successful countries, providing guidance to schools, ensuring equal opportunities, increasing the number of instructional hours, revising the grading and feedback system.

When examining the reasons for Türkiye's underperformance and recommendations for improvement, the second category identified focuses on the learning and teaching process. This category includes perspectives on how addressing the identified issues and implementing suggested changes could lead to better performance in these exams. Views related to this category are presented in Table 7.

Table 7. Issues and Recommendations Related to the Learning-Teaching Process

Issues		Recommendation	
Code	**f**	**Code**	**f**
Rote learning approach	16	Teaching higher-order thinking skills	29
Inability to relate mathematics education to daily life	7	Revising textbooks to align with exam requirements	24
Textbooks not being exam-oriented	7	Implementing experiential learning models	12
Lack of focus on problem-solving and thinking skills	6	Providing education connected to daily life	9
Insufficient emphasis on experiential learning	4	Asking questions that require higher-order thinking skills	8
Failure to instill a spirit of inquiry	2	Conducting reading and comprehension activities	5
Curriculum stifling students' imagination	1	Increasing the focus on projects	3
Resource books not being exam-oriented	1	Using teaching techniques appropriate to the nature of mathematics	3
		Enhancing the use of materials	1
		Implementing tiered systems/level classes in mathematics instruction	1
		Including the history and philosophy of mathematics in the curriculum	1
		Eliminating math anxiety	1

Table 7 shows that the participants identified several issues with the learning and teaching process. These include a rote learning approach, misalignment of the curriculum with exam requirements, and a lack of connection between mathematics education and daily life. Other problems mentioned were textbooks not being exam-focused, failure to ask questions that encourage critical thinking, insufficient experiential learning opportunities, inability to foster a research mindset, curriculum constraints on creativity, and non-exam-focused supplementary materials.When offering suggestions for improving Türkiye's performance in international exams, most of the participants (41 out of 60) emphasized the need for the mathematics curriculum to be specifically designed to align with international exams. Additionally, the participants recommended the teaching of higher-order thinking skills, revising textbooks to be exam-oriented, implementing experiential learning models, connecting teaching to daily life, including questions that require higher-order thinking in exams, and incorporating reading comprehension activities. The following quotes highlight the variables that need improvement in the learning and teaching process.

> *"The rote learning approach is gradually being phased out. Students often struggle because they do not know where or how to apply the information they have learned, which leads to failure." T20 (Male, Age: 38)*

> *"Students struggle to relate the topics they study to daily life, and the questions in their textbooks often do not align with the questions found in standardized tests."T21 (Female, Age:38)*

> *"Our educational programs and teaching models in schools are not aligned with these exams."T47 (Male, Age:42)*

> *"The inclusion of question types not covered in supplementary materials and the unsuitability of textbooks."T52 (Female, Age:30)*

The third category identified from the data is why Türkiye has yet to achieve the expected success, and suggestions for improvement pertain to the professional competencies of mathematics teachers. This category includes views from the participants who believe that addressing the causes of failure and implementing proposed solutions could lead to success in these exams. The insights related to this category are presented in Table 8.

Table 8. Issues and Recommendations Related to the Professional Competencies of Mathematics Teachers

Issues		Recommendation	
Code	**f**	**Code**	**f**
Lack of adequate knowledge of international exams	10	Providing information on international exams to teachers	20
Failure to teach the logic behind topics	2	Solving example questions from international exams in class	12
Insufficient knowledge in preparing high-level thinking questions	2	Encouraging students to use high-level thinking skills	11
Excessive adherence to the curriculum	1	Using real-life examples	9
		Diversifying question levels in class	6
		Staying open to technological advancements and innovations	3
		Improving professional conditions for teachers	3
		Conducting research on international exams	2
		Revising student assignments	2
		Providing feedback to students	1
		Adapting the curriculum to international exams	1
		Allowing teachers autonomy in resource use	1
		Granting teachers autonomy in time and content management	1

As shown in Table 8, the participants discussed several issues related to mathematics teachers' professional competencies. They mentioned a need for more adequate knowledge about international exams, failure to teach the logic behind topics, and insufficient knowledge in preparing questions which require higher-level thinking. As solutions, the participants recommended providing teachers with information about international assessments, practicing sample questions, guiding students in higher-order thinking skills, providing real-life examples, diversifying question levels, keeping up with innovations and technology, and improving teachers' working conditions. In this category, Teachers 5, 36, and 68 expressed the following views:

> *"Teachers lack sufficient knowledge to prepare for international exams. Mathematics instruction cannot be concretized."T5 (Female, Age:32)*

> *"The teachers' inadequacy in this area, students' lack of motivation, and the overcrowded classroom environment are the most significant reasons."T68 (Male, Age:35)*

> *"Teachers should be provided with information through in-service training and seminars, and a comprehensive study should be conducted. Based on this, a more effective program can be developed." T36 (Female, Age: 38)*

When examining the data on why Türkiye has not achieved the expected success and how to improve it, the fourth category concerns the students' cognitive and affective skills. This category includes the participants' views on the reasons for failure and solutions related to students' cognitive and affective competencies. It reflects the opinions of those who believe that addressing these issues could lead to success in international exams. The codes related to this category are presented in Table 9.

Table 9. Issues and Recommendations Regarding Students' Cognitive and Affective Skills

Issues		Recommendation	
Code	**f**	**Code**	**f**
Students' reluctance to use their thinking skills	8	Providing students with information about the exams	6
Insufficient knowledge levels of students regarding international exams	6	Enhancing students' reading comprehension skills	5
Students' inability to transfer learned information	4	Ensuring that topics are appropriate for students' levels	2
Low levels of preparedness	1	Guiding students based on their personal abilities starting from elementary school	2

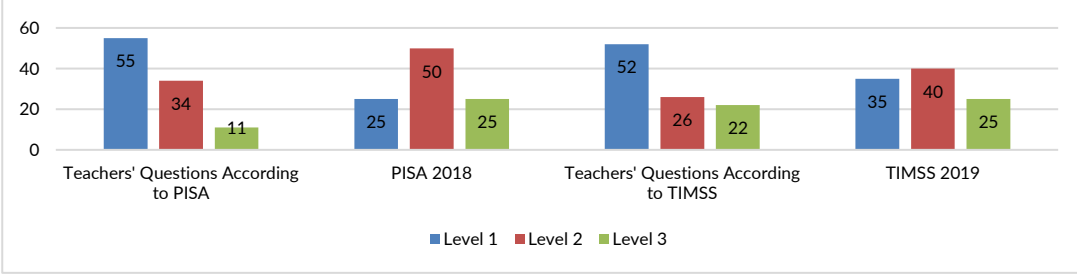
Difficulty in understanding what they read	1	Creating a school environment that fosters students' interests	1
Lack of reading habits	1	Considering students' developmental needs	1
Students' reluctance to answer open-ended questions	1		

As presented in Table 9, teachers emphasized that students' cognitive and affective difficulties play a significant role in Türkiye's limited success in international exams. They pointed out issues such as students' limited engagement in higher-order thinking, lack of exam-related awareness, reading difficulties, and insufficient preparedness. Teachers also noted the importance of addressing students' reluctance toward open-ended questions and their underdeveloped reading habits. To overcome these challenges, they proposed supporting students through early and personalized guidance, enhancing reading comprehension skills, creating interest-based learning environments, and aligning educational content with students' developmental levels and needs. Below are the quotes related to this category:

> *"Students' inability to solve logic questions, the focus on training students in test techniques rather than logic from the first grade, and the lack of emphasis on developing analytical skills. These are the reasons. Additionally, there is a need to improve in providing questions that promote thinking and reflection." T45 (Female, Age: 42)*
>
> *"I believe that the failure in the PISA exam is due to the lack of sufficient knowledge and skills among both students and teachers." T11 (Female, Age:36)*
>
> *"Students are not encouraged to think critically or engage in research and inquiry; instead, they focus solely on results. Additionally, the exam system in our country reinforces this approach." T56 (Male, Age:36)*
>
> *"The content of textbooks should closely align with the types of questions found in these exams. Additionally, topics should be presented in a way that connects with real-life situations to make the material more relatable for students." T36 (Female, Age: 38)*
>
> *"From the very beginning of primary school, starting in the first grade, we need to focus on developing students' skills in reading books, making interpretations, and analyzing and solving questions." T45 (Female, Age: 42)*

In light of mathematics teachers' views on international exams, the levels of their own exam questions were analysed to compare with the levels of questions asked in international assessments. Findings regarding the levels of questions in the exams prepared by the teachers are presented in Appendix 4. To facilitate the interpretation of the data presented in Appendix 4, Figure 1 has been created. Figure 1 compares the distribution of question levels in the recently reported TIMSS and PISA exams with the distribution of questions prepared by the teachers.

Figure 1. Levels of Questions Included in the Exams Prepared by Teachers



According to the data presented in Figure 1, the TIMSS exam conducted in 2019 included 35% of questions at the knowledge level (Level 1). In comparison, 52% of the questions prepared by teachers fell into this category. For the second level, which assesses application, TIMSS featured 40% of questions at this level, while only 26% of the teachers' questions were at this level. At the reasoning level (Level 3), TIMSS included 25% of questions, but just 22% of the questions prepared by teachers reached this level. When evaluated according to the PISA framework, the 2018 PISA exam had 25% of questions at the reorganization level (Level 1), whereas 55% of the teachers' questions were at this level. PISA included 50% of questions at the connection level (Level 2), with 34% of the teachers' questions at this level. For the reflection level (Level 3), PISA had 25% of questions, but only 11% of the questions prepared by teachers were at this level.

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

This study investigated mathematics teachers' awareness and experiences regarding international exams in Türkiye, specifically focusing on PISA and TIMSS. It also examined the cognitive levels of the exam questions they prepared. The findings reveal that most of the teachers do not use PISA and TIMSS exams as a reference when creating their own exam questions, and very few teachers are formally informed about these exams. Instead, most teachers have learned about these exams through social or written media. These results suggest that teachers needed to receive adequate information about these international exams during their pre-service training. This finding is consistent with a similar study evaluating the perspectives of mathematics teacher candidates on PISA and TIMSS exams, which found that many candidates were not familiar with international exams prior to the study (İpek et al., 2016). This situation indicates a clear need for in-service training on large-scale international exams. The literature supports this conclusion, showing that insufficient knowledge among teachers is a consistent factor in poor performance on these exams (Altun & Akkaya, 2014; Çolakoğlu, 2018; İpek et al., 2016; İskenderoğlu & Baki, 2011; İskenderoğlu et al., 2013; Güner et al., 2013). Additionally, studies indicate that teachers have often been inadequately informed about international exam practices during their pre-service and in-service training (Çolakoğlu, 2018; Delil & Özcan, 2019; Güner et al., 2013). This underscores the need to integrate international exam frameworks and high-level thinking skills into teacher training programs, with a strong emphasis on authentic assessment practices. The participants clearly expressed a need for in-service training that addresses the scope and execution of international exams, the structure of exam questions, the teaching of skills evaluated by these exams, and the development of questions that require higher-order thinking. They also highlighted the importance of examining curricula from countries that perform well in these exams. However, some participants pointed out that in-service training might not be effective without revisions to the existing mathematics curriculum. This suggests that mathematics teachers view the curriculum as a more critical factor than pre-service training. The situation not only reflects a high level of adherence to the curriculum but also emphasizes the need to revise the mathematics curriculum to align with international exam standards (Güzel-Yüce, 2022). The findings suggest that the curriculum should support teachers in adapting their practices to meet the theoretical frameworks of these exams. Additionally, the related research highlights the need for ergonomic digital teaching tools and platforms to aid teachers in making these adaptations effectively (Choppin et al., 2018; Davis & Krajcik, 2005).

The second focus of this research is to determine mathematics teachers' perspectives on the current state of international exams in our country. Teachers provided their views and suggestions across four main categories: the education system and philosophy, the mathematics learning and teaching process, the qualifications of mathematics teachers, and students' cognitive and affective development. Most teachers highlighted the need to review the mathematics curriculum better to align it with the frameworks of these international exams.The findings also indicate

that teachers see the inadequacies in curriculum content and teacher expertise as key factors contributing to students' poor performance on these exams (Altun & Akkaya, 2014). Therefore, improving these two areas emerges as crucial for enhancing performance. Furthermore, national exams should be designed to align with the types of questions used in international assessments. Kaya (2019) suggests that central exams should incorporate skills measured by international tests such as PISA and TIMSS and include questions that assess higher order thinking skills. Similarly, Delil and Özcan (2019) emphasize that teachers should receive support to develop higher level cognitive items for more reliable testing.

The need to support mathematics teachers in creating higher level cognitive questions is highlighted by analyzing the cognitive levels of the exam questions they prepare, compared to international assessments like PISA and TIMSS. The review of the tests created by the participants showed that most questions were multiple-choice, and many of these questions were at lower cognitive levels according to the standards of both PISA and TIMSS. It is important to note that the preference for multiple-choice questions may be influenced by the requirements of the "Transition to High School Exam," reflecting the demands of other educational stakeholders such as school administrators, parents, and students. Additionally, when evaluating the PISA and TIMSS frameworks, it was found that out of 1,316 questions prepared by mathematics teachers, most were at lower cognitive levels compared to those required by these international assessments. Among 20 participants, only one teacher's questions were close to the cognitive levels of PISA, and only two teachers' questions were close to those of TIMSS. The results indicate that mathematics teachers need training in developing open-ended questions that assess higher order thinking skills during both pre-service training and in-service education. This is supported by Güler (2021), who found that middle school mathematics teachers' exam questions were predominantly at levels 1 and 2 of the PISA framework, with no questions at levels 5 or 6. Therefore, it can be concluded that mathematics teachers' exams primarily assess students' ability to recall information. Another study revealed that teachers' exam questions mainly focus on recall (%60), procedural methods showing how tasks are performed (%20), and questions that encourage students to think critically (%20) (Gall, 1984). Furthermore, majority of questions in mathematics teaching knowledge exams are geared toward routine procedures requiring factual knowledge (Moralı, Karaduman &Uğurel, 2014). A study examining the mathematics curriculum in Türkiye in relation to TIMSS found that both the old and new curricula emphasize recall skills more heavily (Kılıç, Tutak & Ertaş, 2014), which supports the findings of the current study. This suggests that the insufficient knowledge of mathematics teachers in creating questions that assess higher order thinking skills may be a contributing factor. Another researcher found that while teachers' questions were aligned with learning objectives, they did not effectively measure critical and creative thinking skills (Yakacı, 2016), which also aligns with the results of the current study.

It is evident that educational stakeholders need training in both classroom and large-scale assessment processes to monitor students' mathematical learning effectively and to shape future teaching practices. The study's initial findings indicate that 8th-grade teachers prefer using teaching programs, textbooks, and resource books over international exams for exam preparation. This preference suggests a gap in the utilization of international assessments. Literature reviews support the importance of curricula and textbooks in the assessment and evaluation process (Altun & Akkaya, 2014; İskenderoğlu & Baki, 2011; Güner, Sezer & Akkuş-İspir, 2013). Therefore, a crucial outcome of this study is the need to review and align curricula, textbooks, and resource materials with the assessment frameworks of international exams. The reluctance of teachers to adapt their practices according to international exam frameworks might be related to the focus on national, large-scale exams, such as those for high school transition. Çetin and Ünsal (2019) suggest that the limited use of international exams by teachers may be due to the potential negative impact of centralized exams on

teachers. The low number of teachers utilizing PISA and TIMSS despite their prominent media coverage could indicate a lack of integration between teaching programs and international exam frameworks.

Examining the questions prepared according to the 2018 PISA framework reveals that most are at the "reproduction" level (level one). Questions at the "connection" (level two) and "reflection" (level three) levels are notably fewer compared to those in the PISA exam. This suggests that the questions focus primarily on mathematics content knowledge without integrating real-life contexts. Additionally, findings from studies on the cognitive levels of secondary school math program outcomes indicate that the cognitive level of the curriculum itself may be a contributing factor (Aygün, Baran-Bulut & İpek, 2016; Çelik, Kul &Çalık-Uzun, 2018; İlhan & Aslaner, 2019; İncikabı, Ayanoğlu, Aliustaoğlu, Tekin &Mercimek, 2016). The limited number of "reflection" level questions suggests that, despite teachers' awareness of higher order thinking instruction, there are gaps in their ability to create such questions. This underscores the need for practical training in developing open-ended questions that promote higher-order thinking (İnceçam, Demir & Demir, 2018). Although detailed analysis and evaluation of PISA and TIMSS reports are essential in mathematics education, efforts have largely been confined to seminars conducted by the MoNE, with limited scientific review of the exam results and their implications. Despite a noticeable increase in math exam scores in 2018, these scores remain below the OECD average. Criticisms have been raised regarding the standards for sample selection and cultural sensitivity in these exams. Additionally, the focus on exam results in the media, particularly in the written press, reflects a problematic cycle where criticism of the education system has not led to effective solutions.

Assessing the effectiveness of a country's educational policies and using these assessments to enhance its education system and align with global standards is crucial. In Türkiye, the misalignment between the curriculum, international exams, and national centralized examinations may lead to a lack of perceived need for teachers to learn and adapt to international exams, which results in a gap in teachers' experiential knowledge. However, the literature shows that experiential knowledge also enhances theoretical knowledge and vice versa (Lunenberg &Korthagen, 2009). When teachers do not see the relevance of international assessments to their daily teaching practices, they are less likely to incorporate these assessments into their instruction (Hoban, 2005). This gap suggests that there needs to be a concerted effort to integrate these frameworks into the national curriculum and teacher training programs to foster a more comprehensive understanding and application of international assessments. By doing so, teachers can gain practical experience with international assessments, and therefore, they can enrich their theoretical understanding and improve their instructional practices.

This study provides some insight into the issues and potential solutions, though it has its limitations. One key limitation is the relatively small sample size of 68 participants. To improve the reliability and validity of future findings, a larger sample size is recommended. Additionally, there is a need for action research focusing on developing mathematics exams that align with international large-scale assessment frameworks. This would provide deeper insights into the effectiveness of such assessments. As Hoang (2024) points out, while these reports are frequently scrutinized by policymakers, educational researchers, media, and the public, it is important to acknowledge that they also face significant criticism regarding their limitations.

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APPENDIX

Appendix 1. Personal Characteristics of Mathematics Teachers Participating in the Study

Characteristics	Groups	**f**
Gender	Female	41
	Male	27
Age	26-34	21
	35-44	33
	45 and above	14
Faculty Graduated	Faculty of Education	55
	Faculty of Arts and Sciences	10
	Others	2
Education Level	Bachelor's degree	54
	Master's degree	9
	PhD Degree	5
Seniority	1-5 years	6
	6-10 years	13
	11-15 years	18
	16-20 years	14
	21 years and above	17
Types of School Worked	State School	54
	Private School	9
	Vocational High School	5
Taking Measurement and Evaluation Course	Yes	66

	No	2
Attending Measurement and Evaluation Seminars or Training	Yes	39
	No	29
Attending PISA Seminar or Training	Yes	1
	No	67
Attending TIMSS Seminar or Training	Yes	-
	No	68

Appendix 2: Coding Key for Teacher Questions According to the PISA Framework

Category	Defination	Cognitive Process	Indicators
Reproduction	Questions that involve repeating the exact same information provided and those that require performing simple operations are coded in this category.	Recall, Comprehension, Application	Repeats the same information at the application level Knows representations and definition Explains simple and familiar representations Performs routine calculations and operations Carries out routine procedures Solves routine problems Interprets a simple table
Connections	Questions that require interpreting the presented information or using it in a different context are coded in this category.	Integration, Analysis	Connects mathematical structures to real-life situations Solves non-routine problems Expresses problem situations mathematically Performs simple mathematical reasoning Uses well-defined methods Engages in discussions based on the interpretation of data
Reflection	Questions that require evaluating and discussing information presented in a different context are coded in this category.	Mathematical Thinking Evaluation, Creation, Generalization and Insight Development	Solves and formulates complex problems Reflects complex problems mathematically Creates original mathematical approaches Communicates reasoning with complex arguments Uses multiple complex methods Makes generalizations

Source: Adapted from Shiel, Perkins, Close, and Oldham 2007:6.

Appendix 3: Coding Key for Teacher Questions According to the TIMSS Framework

Category	Defination	Cognitive Process	Indicators
Knowing	Questions that involve repeating the exact same information provided and those that require performing simple operations are coded in this category.	Recall, Comprehension, Classify/Order, Compute, Retrieve, Measure	Recalls mathematical knowledge such as definitions, terminology, and number properties
			Recognizes numbers, expressions, quantities, and shapes
			Identifies mathematically equivalent entities
			Classifies numbers, expressions, quantities, and shapes based on common properties
			Extracts information from graphs, tables, text, or other sources
			Uses measurement tools and selects appropriate units of measurement
Applying	Questions that require interpreting or using the presented information are coded in this category.	Determine, Represent/Model, Implement	Identifies appropriate strategies and tools for solving problems that involve commonly used solution methods
			Displays data in tables or graphs
			Creates equations, inequalities, geometric shapes, or diagrams that model problem situations
			Produces equivalent representations for a given mathematical entity or relationship
			Applies strategies and procedures to solve problems involving known mathematical concepts and procedures
Reasoning	Questions that require evaluating and discussing information presented in a different context are coded in this category.	Analyze, Integrate/Synthesize Evaluate, Draw Conclusion, Generalize, Justify	Identifies relationships among numbers, expressions, quantities, and shapes
			Defines or uses relationships among numbers, expressions, quantities, and shapes
			Relates different elements of knowledge, relevant representations, and procedures to solve problems
			Evaluate solutions using alternative problem-solving strategies
			Makes valid inferences based on information and evidence related to the results
			Expresses relationships using more broadly applicable terms
			Provides mathematical arguments to support a strategy or solution

Source: Adapted from Mullis and Martin 2017: 23-24.

Appendix 4: Levels of Problems Included in the Exams Administered by Teachers

	TIMSS			PISA			
Participants	**Knowing % (f)**	**Applying % (f)**	**Reasoning % (f)**	**Reproduction %(f)**	**Connection %(f)**	**Reflection %(f)**	**Total Number of Questions**
T1	26 (21)	20 (16)	54 (44)	**29 (23)**	**44 (36)**	**27 (22)**	81
T2	47 (34)	22 (16)	31 (22)	51 (37)	29 (21)	19 (14)	72
T3	59 (44)	26 (19)	16 (12)	67 (50)	21 (16)	12 (9)	75
T4	57 (44)	14 (11)	29 (22)	58 (45)	27 (21)	14 (11)	77
T5	42 (31)	30 (22)	28 (21)	54 (40)	27 (20)	19 (14)	74
T6	72 (56)	13 (10)	15 (12)	72 (56)	18 (14)	10 (8)	78
T7	46 (24)	29 (15)	25 (13)	52 (27)	27 (14)	22 (11)	52
T8	69 (55)	10(8)	21 (17)	70 (56)	26 (21)	4 (3)	80
T9	48 (30)	19 (12)	34 (22)	48 (31)	33 (21)	20 (12)	64
T10	70 (41)	7 (4)	23 (14)	69 (41)	22 (13)	9 (5)	59
T11	53 (28)	32 (17)	15 (8)	53 (28)	34 (18)	13 (7)	53
T12	58 (35)	35 (21)	7 (4)	58 (35)	35 (21)	7 (4)	60
T13	50 (40)	38 (30)	13 (10)	54 (43)	41 (32)	6 (5)	80
T14	47 (24)	20 (10)	33 (17)	47 (24)	47 (24)	6 (3)	51
T15	58 (37)	27 (17)	16 (10)	64 (41)	36 (22)	2 (1)	64
T16	57 (20)	29 (10)	14 (5)	57 (20)	42 (15)	0 (0)	35
T17	**44 (25)**	**42 (23)**	**13 (7)**	47 (26)	47 (26)	7 (3)	55
T18	**38 (20)**	**47 (25)**	**18 (8)**	45 (24)	51 (27)	5 (2)	53
T19	48 (38)	51 (41)	1 (1)	48 (38)	51 (41)	1 (1)	80
T20	43 (31)	52 (38)	5 (4)	48 (35)	47 (34)	5 (4)	73
Exam Distribution	**35%**	**40%**	**25%**	**25%**	**50%**	**25%**	
Total Number of Questions	52% (678)	28% (365)	21% (273)	55% (720)	35% (457)	11% (139)	100% (1316)