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Examination of Elementary School Mathematics Teachers' Mathematical Modelling Attitudes in Terms of Various Variables

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Abstract. This study aims to examine elementary mathematics teachers' attitudes towards mathematical modelling in terms of various variables. The current study is particularly important as it is one of the few ones in our country to investigate this type of work, focusing on the attitudes of elementary mathematics teachers towards mathematical modelling across all sub-dimensions. A survey model, one of the quantitative research methods, was used, and the sample of the study consisted of 102 elementary mathematics teachers working at official secondary schools and official imam hatip secondary schools in Aydın province during the 2023-2024 academic year, determined through an appropriate sampling method. The Mathematical Modelling Attitude Scale was used as the data collection tool in the study. The research revealed that elementary mathematics teachers exhibit a low level of attitude towards mathematical modelling. Although their motivation sub-dimension towards mathematical modelling was high, the real-life sub-dimension was moderate, while the constructivism and understanding sub-dimensions were low. However, it was found that the sub-dimension and overall scores of the mathematical modelling attitude scale of elementary mathematics teachers did not differ according to gender, faculty of graduation, age, and professional experience, but they did differ according to level of education.

Keywords: Mathematical modelling, attitude towards mathematical modelling, elementary school mathematics teachers.

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Given the current era, it is evident that science and technology continuously affect our lives, driving change and development in today's world. This situation has also pushed the education community towards change, emphasizing the importance of learning to think, thinking creatively, producing solutions to encountered problems with creative ideas, and being able to use what is learned in daily life. In this context, mathematics plays a critical role in raising individuals who can transform their knowledge and skills into practical applications in daily life (Tutak & Güder, 2014).

Mathematics education in schools is often perceived as a purely abstract science where formulas are memorized and detached from real life. However, it is clear that teaching mathematics in a way that helps individuals in their daily lives will benefit them in overcoming problems they may encounter. Today, individuals are integrating mathematics into their lives and taking steps to concretize mathematics, an abstract science, by relating it to their daily lives. One of the most important methods used for this purpose is the modelling of mathematics. When we look at it, mathematics is a systematic way of thinking that seeks solutions to problems encountered in life through modelling. When mathematics is associated with daily life, it is seen that the foundation of mathematical concepts exists within life itself (Demir, Sert, Çelik, Arı, & Kaleli Yılmaz, 2023).

In the world of education, the concept of a model is also of great importance. According to the Turkish Language Institution's Contemporary Turkish Dictionary, a model is defined as “the first example of a designed product produced for promotion or testing purposes, a prototype” (Turkish Language Institution, 2023). While modelling is considered a process, the model is described as the product created as a result of this process (Özturan, Sağırlı, Kırmacı, & Bulut, 2010). During the modelling process, efforts are made to understand problem situations, think about and apply possible solutions, and develop models that will ensure a clear understanding of the problem. Mathematical modelling, considered a subcategory of the modelling concept, refers to a cyclical process consisting of concrete models that will facilitate the understanding of the abstract structure of real-life problems (Lesh & Doerr, 2003). In this cyclical process, an abstract daily life problem is concretized, expressed in mathematical language, solved with creative solutions, and these solutions are evaluated (Lesh & Haines, 2010). Therefore, mathematical modelling is a process that includes revisions before reaching an acceptable conclusion and involves movement between elements such as a real-world situation, a mathematical phenomenon, and a mathematical solution (Asempapa, 2020). In modelling activities, students work like researchers to solve problem situations taken from daily life using mathematics and aim to reach a generalization that can be used for similar situations (Doruk, 2010). This helps to establish the relationship between mathematics and real-life situations, allowing students to learn mathematics more meaningfully (Asempapa, 2022).

As mentioned in the statement by the National Council of Teachers of Mathematics (NCTM) (2000), which holds an important place in mathematics education, the importance of using mathematical models in problem-solving processes is emphasized in teaching programs at every grade level, starting from early childhood, to make mathematical learning more meaningful. In our country, as on a global scale, many areas have observed development and change. The beginning of fundamental changes in the field of education started with the new elementary education program implemented since 2005. The basis of this program is the changing roles of teachers and students, changes in the learning environment, and differentiation in mathematical learning. With this program, mathematical modelling and models were comprehensively included for the first time (Ministry of National Education, 2005). Since then, there has been a greater emphasis on mathematical modelling in teaching programs, and it has been suggested as a skill to be used in the teaching process by preparing learning environments based on problem-solving and modelling activities that contain daily life situations suitable for students' levels and interests to apply the program's perspective (Ministry of National Education, 2018). Additionally, when examining textbooks, it is seen that there are daily life problems that require modelling in certain sections. When examining the Turkey Century Maarif Program, the Mathematics Course Teaching Program is associated with four basic skills: mathematical problem-solving, analysis, interpretation, developing mathematical solutions, and reflection, and their process components. The process components under these skills are the ability to develop strategies based on intuition and experience, apply these strategies, evaluate the solution of the problem and the applied strategy from various perspectives, and use mathematical modelling (Ministry of National Education, 2024).

When examining the general competencies of the teaching profession published by the Ministry of National Education, it is seen that among the competencies that teachers should have are the ability to relate lessons to daily life, use appropriate methods and approaches in lessons, and recognize, understand, and implement the current teaching program. As can be seen, teachers are expected to have the modelling skill, which is one of the skills addressed in teaching programs, and to use planning, organizing, and pedagogical content knowledge to transfer these skills to their students in the classroom (General Directorate of Teacher Training and Education, 2017). Additionally, since teachers play an important role in student success, negative attitudes they may have towards mathematical modelling can harm the modelling applications they will conduct, thereby affecting students' learning (Asempapa & Brooks, 2022). In this context, it is necessary to determine the attitudes of teachers towards mathematical modelling and identify ways to increase productivity, especially towards mathematical modelling in the classroom.

When examining the literature, it is seen that studies focus on the mathematical modelling process (Eraslan, 2012; Tekin Dede & Bukova Güzel, 2013), the development of mathematical modelling skills (Bal & Doğanay, 2014), mathematical modelling competencies (Tekin Dede & Yılmaz, 2013), the awareness of mathematics teachers and prospective mathematics teachers towards modelling (Akgün et al., 2013; Sarı & Özturan Sağırlı, 2021; İncikabı & Biber, 2020), the opinions of mathematics teachers and prospective mathematics teachers towards modelling (Urhan & Dost, 2016; Yanık & Koparan, 2017; Işık & Mercan, 2015; Tutak & Güder, 2014; Aslan & Yadigaroğlu, 2013; Tekin & Bukova Güzel, 2011), the perceptions of prospective mathematics teachers towards modelling (Durandt & Jacobs, 2014; Arı, Demir & Çakır, 2023), and the views of elementary school teachers and prospective elementary school teachers towards mathematical modelling and their perceptions of mathematical modelling (Albayrak & Efendioğlu, 2023; Pilten, Serin & Işık, 2016). Studies on students' attitudes and habits towards mathematical modelling (Mehraein & Gatabi, 2014; Fitri & Hiltrimartin, 2020; Durandt, Blum & Lindl, 2022) are also encountered in the literature. Additionally, there are studies on measuring teachers' attitudes towards mathematical modelling, including the design of the scale (Asempapa, 2020), the adaptation of the designed scale for teachers in different countries (Hidayat et al., 2021; Demir et al., 2023), and the measurement of changes in teachers' attitudes towards mathematical modelling according to demographic variables (Asempapa, 2022). Asempapa's (2022) study shows parallelism with our study in terms of examining demographic variables. However, the current research is particularly important as it is one of the few studies conducted in our country, and it aims to reveal the attitudes of elementary mathematics teachers towards mathematical modelling in all its sub-dimensions. Teachers are key factors in the process of understanding and applying mathematical modelling standards. How they perceive mathematical modelling and their attitudes towards it are very important. The reflection of teachers' attitudes towards mathematical modelling will naturally be seen in their students. Mathematical modelling aims to provide students with the ability to relate abstract mathematical concepts to daily life and use them in practical applications. Teachers' attitudes towards mathematical modelling can help evaluate their in-class activities to achieve these goals. Additionally, measuring teachers' attitudes towards mathematical modelling offers the opportunity to understand which teaching methods and strategies are used in the classroom and the teacher's approach to modelling. This will guide teachers in becoming aware of their strengths and weaknesses in mathematical modelling. Mathematical modelling can help students understand mathematical topics more deeply and produce easier solutions to problems they may struggle with. Teachers' attitudes towards using this approach play a key role in increasing student success and understanding levels. Since mathematical modelling offers students the opportunity to relate mathematics to daily life, it can increase motivation. Teachers' adoption of this approach can contribute to students developing a more positive attitude towards mathematics classes and showing more participation in the lesson. Positive attitudes of teachers towards modelling will encourage student-centered learning by providing opportunities for students to develop their own solutions and create mathematical models. Measuring teachers' attitudes towards mathematical modelling can guide the determination of educational policies and the design of teacher education programs. This data can be used to determine the priorities that need to be set in teacher education and professional development areas. Measuring teachers' attitudes towards mathematical modelling is an important step to improve the quality of education and develop students' mathematical skills. This measurement can help make decisions to improve educational processes and develop more effective teaching strategies. In this context, the research conducted is important.

The purpose of the current research is to measure the attitudes of elementary mathematics teachers, who are the practitioners of mathematical modelling activities in the classroom, towards mathematical modelling and to measure these attitudes in terms of various variables. In line with this purpose, the following question is sought: “Do the attitudes of elementary mathematics teachers towards mathematical modelling differ according to various variables?” The sub-problems related to this question are as follows:

1. What are the attitudes of elementary mathematics teachers towards mathematical modelling?
2. Do the attitudes of elementary mathematics teachers towards mathematical modelling differ according to gender?
3. Do the attitudes of elementary mathematics teachers towards mathematical modelling differ according to age?
4. Do the attitudes of elementary mathematics teachers towards mathematical modelling differ according to the type of faculty they graduated from?
5. Do the attitudes of elementary mathematics teachers towards mathematical modelling differ according to their level of education status?

6. Do the attitudes of elementary mathematics teachers towards mathematical modelling differ according to their professional experience?

Method

Research Model

In this research, which aims to examine the attitudes of elementary mathematics teachers towards mathematical modelling in terms of various variables, a general survey model, which is one of the quantitative research methods, was used to describe the attitudes, behaviours, and other stages of a sample or universe by applying a questionnaire, test, or scale to the researchers (Creswell, 2012; Fraenkel et al., 2012).

Study Group

The population of the research consists of mathematics teachers working in official secondary schools and official imam hatip secondary schools in Aydın province during the 2023-2024 academic year. The sample of the research consists of 102 elementary mathematics teachers working in official secondary schools and imam hatip secondary schools in Aydın province, who voluntarily participated in the research during the data collection process. An appropriate sampling method was used for being easily accessible and applicable (Büyüköztürk et al., 2023).

Table 1.

Information on Demographic Data

Demographic Information	Variable	f	%
Gender	Female	65	63.7
	Male	37	36.3
	Total	102	100.0
Age	21-30 Years	6	5.9
	31-40 Years	53	52.0
	41-50 Years	38	37.3
	Over 50 years	5	4.9
	Total	102	100.0
Educational Degree	Bachelor's	77	75.5
	Master's without Thesis	10	9.8
	Master's with Thesis	15	14.7
	Doctorate	-	-
	Total	102	100.0
Faculty Graduated From	Faculty of Education	93	91.2
	Faculty of Science and Literature	9	8.8
	Total	102	100.0

Professional Experience	1-5 years	1	1.0
	6-10 years	18	17.6
	11-15 years	36	35.3
	16-20 years	32	31.4
	Over 20 years	15	14.7
	Total	100	100.0

When the frequency and percentage distribution in Table 1 are examined, it is seen that there are 65 female (63.7%) and 37 male (36.3%) participants. When the distribution of elementary mathematics teachers is examined according to age ranges, it is seen that the majority of the teachers are between 31-40 years old (52%). Regarding educational degrees, it is seen that only those with a bachelor's degree (75.5%) are predominant. In terms of the graduated faculty type, it is observed that the majority of teachers graduated from the Faculty of Education (91.2%). When the professional experiences are examined, it is seen that the majority of teachers have 11-15 years (35.3%) and 16-20 years (31.4%) of experience.

Data Collection Tools

As a data collection tool, the Mathematical Modelling Attitude Scale (MMAS) developed by Demir, Sert Çelik, Arı and Kaleli Yılmaz (2023) and a demographic information form prepared by the researcher were used.

Demographic information form. The "Demographic Information Form" will be used to examine the mathematical attitudes of elementary mathematics teachers in terms of age, gender, graduated faculty, completed education status, and professional experience.

Mathematical modelling attitude scale (MMAS). In this study, the Turkish adaptation of the Mathematical Modelling Attitude Scale (MMAS) developed by Asempapa (2020) to determine the attitudes of teachers who teach mathematics towards mathematical modelling was used by Demir, Sert Çelik, Arı and Kaleli Yılmaz (2023). The attitude scale consists of 24 items. These items are rated on a six-point Likert scale, ranging from 6 "Strongly Agree" to 1 "Strongly Disagree." In the study conducted by Demir, Sert Çelik, Arı and Kaleli Yılmaz (2023), the items were evaluated by taking expert opinions, and it was decided to use the original four-dimensional and 28-item version of the scale. Subsequently, the validity and reliability study of the scale was conducted. The exploratory factor analysis (EFA) revealed that the four-factor structure explained 62.8% of the total variance. The confirmatory factor analysis (CFA) result showed that the scale had four dimensions, with factor loadings ranging from 0.600 to 0.889, and the Cronbach alpha coefficient was 0.935 for all, 0.814 for the constructivism factor, 0.922 for the motivation and relevance factor, 0.872 for real-life, and 0.796 for the understanding factor. The convergence validity coefficients ranged from 0.868 to 0.943, and the discriminant validity (AVE) ranged from 0.415 to 0.627. As a result, it was stated that the four-dimensional and 24-item Turkish adaptation of the MMAS is a valid and reliable measurement tool to measure the attitudes of teachers who teach mathematics towards mathematical modelling.

Process

In this research, the data collection tool was the Mathematical Modelling Attitude Scale (MMAS) adapted into Turkish by Demir Sert-Çelik Arı and Kaleli-Yılmaz (2023) and originally prepared by Asempapa (2019). The administration of the scale takes an average of 15 minutes per person. The application was conducted face-to-face with the participants. The data were collected within three weeks. The factors constituting the scale are constructivism, understanding, relevance, and real-life, and motivation and interest. The Cronbach's alpha coefficients for these factors range from 0.81 to 0.95, while the general scale coefficient is 0.96. The items on the scale are scored on a six-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree," and all items consist of positive statements. In this study, the Cronbach's alpha reliability coefficient of the scale was found to be; constructivism = 0.90, understanding = 0.89, real-life = 0.93, motivation = 0.96, and MMAS general total = 0.97.

Data Analysis

The data were analyzed using a statistical package program. The data were subjected to a normality test, but it was determined that it did not have a normal distribution (Table 2). Therefore, non-parametric Mann-Whitney U test, Kruskal-Wallis H test, and descriptive statistical analysis were conducted to analyze the data that did not show normal distribution. Post Hoc Tamhane's T2 test was performed to determine the difference between groups.

Table 2.

Normality Test

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	p	Statistic	df	p
Constructivist Sub-dimension	,258	102	,000	,811	102	,000
Understanding Sub-dimension	,218	102	,000	,830	102	,000
Real-life Sub-dimension	,207	102	,000	,822	102	,000
Motivation Sub-dimension	,199	102	,000	,818	102	,000
MMAS General Total	,164	102	,000	,871	102	,000

Results

Table 3.

Attitude Levels of Elementary Mathematics Teachers towards Mathematical Modelling

Scale and Sub-dimensions	n	$\bar{x}$	Ss.	Range	Min.	Max.
Constructivism	102	12.66	7.82	20.00	5.00	25.00
Understanding	102	11.58	6.32	16.00	4.00	20.00
Real-life	102	16.71	9.77	24.00	6.00	30.00
Motivation	102	27.34	14.64	36.00	9.00	45.00
MMAS Total	102	68.31	34.99	96.00	24.00	120.00

When Table 3 is examined, the arithmetic averages of the sub-dimensions of the Mathematical Modelling Attitude Scale for elementary mathematics teachers were calculated as follows: x_constructivism = 12.66, x_understanding = 11.58, x_real-life = 16.71, x_motivation = 27.34, and the overall arithmetic average of the scale was calculated as x_MMAS = 68.31. Considering the data, it is seen that teachers have high motivation, moderate real-life sub-dimension, but low constructivism and understanding sub-dimensions. Among the sub-dimensions of the elementary mathematics teachers' attitude levels towards mathematical modelling, the understanding sub-dimension has the most homogeneous structure with SS = 6.32 and Range = 16, while the motivation sub-dimension has the most heterogeneous structure with SS = 14.64 and Range = 36. It can be stated that teachers are motivated by different factors but have a similar understanding regarding attitudes towards mathematical modelling. It was determined that teachers exhibit a low level of attitude towards mathematical modelling (x_item MMAS = 2.44).

Table 4.

Mann Whitney U Test Result for the Attitude Levels of Elementary Mathematics Teachers Towards Mathematical Modelling According to Gender Variable

Scale and Sub-dimension	Gender	n	S.O.	S.T.	U	z	p
Constructivism	Female	65	49.09	3191.00	1046.500	-1.134	.257
	Male	37	55.73	2062.00			
Understanding	Female	65	51.42	3342.50	1197.500	-.036	.972
	Male	37	51.64	1910.50			
Real-life	Female	65	52.42	3407.00	1143.000	-.425	.671
	Male	37	49.89	1846.00			
Motivation	Female	65	52.09	3386.00	1164.000	-.272	.785
	Male	37	50.46	1867.00			
MMAS Total	Female	65	51.60	3354.00	1196.000	-.046	.964
	Male	37	51.32	1899.00			

In the Mann Whitney U Test analysis shown in Table 4, it was found that the sub-dimensions and overall scores of the Mathematical Modelling Attitude Scale for elementary mathematics teachers did not differ significantly according to the gender variable (p > 0.05). According to this finding, it can be said that the attitude levels of teachers towards mathematical modelling are similar across all sub-dimensions according to the gender variable.

Table 5.

Mann-Whitney U Test Result for the Attitude Levels of Elementary Mathematics Teachers Towards Mathematical Modelling According to the Graduated Faculty Variable

Scale and Sub-dimension	Faculty Graduated From	n	S.O.	S.T.	U	z	p
Constructivism	Faculty of Education	93	50.40	4687.00	316.000	-1.259	.20
	Faculty of Science and Literature	9	62.89	566.00			
Understanding	Faculty of Education	93	51.08	4750.00	379.000	-.476	.634
	Faculty of Science and Literature	9	55.89	503.00			
Real-life	Faculty of Education	93	50.80	4724.50	360.000	-.787	.483
	Faculty of Science and Literature	9	58.72	528.50			
Motivation	Faculty of Education	93	50.87	4731.00	360.000	-.701	.483
	Faculty of Science and Literature	9	58.00	522.00			
MMAS Total	Faculty of Education	93	50.66	4711.00	340.000	-.933	.351
	Faculty of Science and Literature	9	60.22	542.00			

In Table 5, it is seen that the sub-dimensions and overall scores of the Mathematical Modelling Attitude Scale for elementary mathematics teachers did not differ significantly according to the graduated faculty (p > 0.05). According to this finding, it can be said that the attitude levels of teachers towards mathematical modelling are similar according to the type of faculty they graduated from.

Table 6.

Kruskal-Wallis H Test Result for the Attitude Levels of Elementary Mathematics Teachers Towards Mathematical Modelling According to Age Variable

Scale and Sub-dimension	**Age Group**	**n**	**Rank Avarage**	**Sd**	x^2	**p**
Constructivism	20-30 years	6	45,83	3	5.619	.13
	31-41 years	53	46,30			
	41-50 years	38	60,14			
	Over 50 years	5	47,70			
Understanding	20-30 years	6	59,83	3	5.881	.118
	31-41 years	53	44,92			
	41-50 years	38	59,11			
	Over 50 years	5	53,50			
Real-life	20-30 years	6	64,17	3	5.226	.156
	31-41 years	53	45,42			
	41-50 years	38	57,47			
	Over 50 years	5	55,30			
Motivation	20-30 years	6	53,33	3	3.238	.35
	31-41 years	53	46,74			
	41-50 years	38	57,83			
	Over 50 years	5	51,70			
MMAS Total	20-30 years	6	56,25	3	6.454	.091
	31-41 years	53	44,64			
	41-50 years	38	60,30			
	Over 50 years	5	51,60			

When Table 6 is examined, it is seen that the sub-dimensions scores (x^2_constructivism = 5.619, sd = 3, p > 0.05; x^2_understanding = 5.881, sd = 3, p > 0.05; x^2_real-life = 5.226, sd = 3, p > 0.05; x^2_motivation = 3.238, sd = 3, p > 0.05) and the overall scores (x^2_total = 6.454, sd = 3, p > 0.05) of the Mathematical Modelling Attitude Scale for elementary mathematics teachers did not differ significantly according to the age variable. According to this finding, it can be said that the attitude levels of teachers towards mathematical modelling are similar according to their ages variable.

Table 7.

Kruskal-Wallis H Test Result for the Attitude Levels of Elementary Mathematics Teachers Towards Mathematical Modelling According to Educational Degree Variable

Scale and Sub-dimension	Educational Degree	n	Rank Avarage	Sd	x^2	p	Tamhane's T2 (Difference)
Constructivism	1. Bachelor's	77	55.70	2	10.297	**.00***	1< 2 2>1
	2. Master's without Thesis	10	51.45				
	3. Master's with Thesis	15	29.97				
Understanding	1.Master's	77	55.71	2	11.289	**.00***	1< 2 2>1
	2.Master's without Thesis	10	53.85				
	3.Master's with Thesis	15	28.33				
Real-life	1. Bachelor's	77	54.68	2	10.321	**.00***	1< 2 2>3 3<2-1
	2.Master's without Thesis	10	59.75				
	3.Master's with Thesis	15	29.70				
Motivation	1. Bachelor's	77	54.14	2	8.465	**.01***	1< 2 2>3 3<2-1
	2.Master's without Thesis	10	60.65				
	3.Master's with Thesis	15	31.83				
MMAS Total	1. Bachelor's	77	55.62	2	11.798	**.00***	1< 2 2> 3 3<2-1
	2.Master's without Thesis	10	55.90				
	3.Master's with Thesis	15	27.43				

***p<.05**

When Table 7 is examined, it is seen that the sub-dimensions (x^2_constructivism = 10.297, sd = 2, $p < 0.05$; x^2_understanding = 11.289, sd = 2, $p < 0.05$; x^2_real-life = 10.321, sd = 2, $p < 0.05$; x^2_motivation = 8.465, sd = 2, $p < 0.05$) and the overall scores (x^2_total = 11.798, sd = 2, $p < 0.05$) of the Mathematical Modelling Attitude Scale for elementary mathematics teachers differ significantly according to the educational degree variable. The Post Hoc Tamhane's T2 test, conducted to determine the difference between groups, found that elementary mathematics teachers with master's degree with thesis had higher levels of attitudes towards mathematical modelling compared to those with a bachelor's degree and master's degree without thesis.

Table 8.

Kruskal-Wallis H Test Result for the Attitude Levels of Elementary Mathematics Teachers Towards Mathematical Modelling According to Professional Seniority Variable

Scale and Sub-dimension	Professional Seniority	n	Rank Avarage	Sd	x^2	p
Constructivism	1-5 years	1	57.00	4	5.328	.255
	6-10 years	18	40.14			
	11-15 years	36	50.18			
	16-20 years	32	54.31			
	Over 20 years	15	61.93			
Understanding	1-5 years	1	40.50	4	3.234	.519
	6-10 years	18	43.11			
	11-15 years	36	52.92			
	16-20 years	32	50.72			
	Over 20 years	15	60.57			
Real-life	1-5 years	1	54.00	4	3.248	.517
	6-10 years	18	42.81			
	11-15 years	36	50.14			
	16-20 years	32	53.84			
	Over 20 years	15	60.03			
Motivation	1-5 years	1	45.00	4	4.269	.371
	6-10 years	18	39.56			
	11-15 years	36	52.43			
	16-20 years	32	54.00			
	Over 20 years	15	58.70			
MMAS Total	1-5 years	1	44.00	4	5.146	.273
	6-10 years	18	39.58			
	11-15 years	36	50.60			
	16-20 years	32	54.86			
	Over 20 years	15	61.30			

As seen in Table 8, the Kruskal-Wallis H Test conducted to determine whether the scores of the Mathematical Modelling Attitude Scale for elementary mathematics teachers differ significantly according to the professional experience variable found no statistically significant difference among the sub-dimensions (x^2_total = 5.146, sd = 4, $p > 0.05$).

Discussion and Conclusion

This study was conducted to examine the attitudes of elementary mathematics teachers towards mathematical modelling in terms of various variables. Within the scope of the current research, it is seen that teachers have high motivation, moderate real-life sub-dimension, but low constructivism and understanding sub-dimensions. The Real-life sub-dimension examines the applicability of mathematical modelling in daily life and its relationship with real life, and it shows that teachers' level of associating mathematical modelling with real life is moderate. In the study by Akgün et al. (2013), it was determined that only one teacher partially agreed that the method of mathematical modelling represents solving daily life problems with mathematical terms. Additionally, they stated that mathematical modelling visualizes and concretizes problems in daily life, thus helping understanding. However, it was observed that teachers who stated they used mathematical modelling did not express a daily life situation in the mathematical world to their students in mathematical language. This generally shows that teachers are not proficient in the relationship between mathematical modelling and real life.

When examining the items in the Motivation sub-dimension, it can be stated that elementary mathematics teachers are aware of the importance and benefits of mathematical modeling. However, when examining the items in the Constructivism and Understanding sub-dimensions, it can be stated that they experience a lack of knowledge about mathematical modeling. In Eker's (2019) study, mathematics teachers think that modeling requires a different perspective from the traditional problem-solving approach, stating that the modeling process is both fun and useful. Additionally, they state that understanding the importance of mathematics in daily life will increase with modeling questions. This emphasizes the importance and benefits of mathematical modeling, and their findings show that teachers have high motivation but face some difficulties during modeling, which is consistent with our research results. In Saka's (2023) study, it is also indicated that teachers do not have sufficient knowledge about mathematical modeling, and this situation limits the applicability of Model-Eliciting Activities (MEA). Furthermore, it is emphasized that teachers' challenges in classroom management, activity selection, and providing feedback pose obstacles to the implementation of modeling activities. The study by Akgün et al. (2013) also supports the findings of this research, indicating that teachers lack sufficient knowledge about mathematical modeling and often confuse mathematical modeling concepts with various other concepts. Studies conducted by Albayrak and Efendioğlu (2023), Deniz and Akgün (2018), Duran, Doruk, and Kaplan (2016), Işık and Mercan (2015), İncikabı and Biber (2020), Kaya and Keşan (2022), Kertil (2008), Korkmaz

(2010), Özdemir (2014), Pilten et al. (2016), Şahal and Özdemir (2021), Tuna, Biber, and Yurt (2013), and Urhan and Dost (2016) also indicate that teachers have insufficient or incorrect knowledge about mathematical modeling. Considering the historical process of the studies conducted, it is seen that teachers still experience a lack of knowledge about mathematical modeling.

Within the scope of the current research, the results in the Understanding sub-dimension show that teachers have some difficulties in comprehending mathematical modelling. Tekin Dede and Bukova Güzel (2013), Deniz and Akgün (2018), Kaya and Keşan (2022) also reached findings supporting this situation in their studies. Sarı and Özturan Sağırlı (2020) state in their study that this is because the mathematical modelling course is not taught as a separate course in undergraduate education or is superficially covered in some courses. However, it is expected that the reflections of the mathematical modelling course, which is included at the undergraduate or master's degree level in the elementary mathematics teaching program since the 2018-2019 academic year, will be observed in educational environments. However, in Sarı and Özturan Sağırlı's (2020) study, it is observed that this is not the case, and it is determined that taking a mathematical modelling course during the undergraduate period does not cause any change in favour of mathematical modelling in their teaching process. It can be seen that teacher candidates are unable to structure the courses they took during their undergraduate period well and reflect them in their teaching activities. This situation makes it necessary to provide in-service training on mathematical modelling.

The result that teachers generally have high motivation towards mathematical modelling is supported by studies conducted by Arı, Demir, and Çakır (2023), Saka (2023), Sarı and Özturan Sağırlı (2021), and Tekin Dede and Bukova Güzel (2013), which state that teachers have high motivation in this regard, but they cannot allocate much time to mathematical modelling in their lessons due to negative conditions such as limited lesson hours, the possibility of not being able to cover the curriculum topics, and the difficulty of writing a mathematical modelling problem for each topic.

According to the data obtained in the study, there is no statistically significant difference in the attitude levels of male and female teachers towards mathematical modeling. Based on these findings, it can be concluded that gender is not a determining factor in attitudes towards mathematical modeling. Although there are conflicting results in the literature (Asempapa, 2020; Asempapa, 2022), Aslan and Yadigaroğlu's (2014) study with teacher candidates supports this situation. This also shows that the needs for education and support regarding mathematical modelling should be determined based on general needs, not on the basis of gender. This can ensure the more effective use of these educational resources and support gender equality in education. The underlying reasons for the lack of difference in the gender variable in the research can be explained as the sample having received education at similar levels of schools, analyzing and interpreting similar topics during their educational processes, encountering similar problem situations, learning the same content, having identical teaching-learning principles, and having common practice-oriented activities.

As a result of the data obtained, there is no significant difference in the attitude levels towards mathematical modeling between teachers who graduated from the Faculty of Education and those who graduated from the Faculty of Science and Literature. Although the few of participants who graduated from the Faculty of Science and Literature makes generalization difficult, Sarı and Özturan Sağırlı's (2021) study shows that teachers who received education on mathematical modeling at university do not use mathematical modeling in their lessons, just like other teachers who did not receive such education, which supports our study.

As a result of the data obtained in the research, there is no significant difference in the attitude levels towards mathematical modeling among teachers of different age groups. These findings suggest that the attitudes of elementary mathematics teachers towards mathematical modeling do not change with age, that age is not a determining factor in attitudes towards mathematical modeling, and that teachers can exhibit the same level of attitude regardless of their age.

The data obtained show that educational degree has a significant effect on attitudes towards mathematical modeling. Elementary mathematics teachers with a master's degree with thesis exhibit higher levels of attitudes towards mathematical modeling compared to those with a bachelor's degree and a master's degree without thesis. This finding indicates that graduate education has a positive effect on attitudes towards mathematical modeling and that graduate education levels are an important factor in the attitudes of elementary mathematics teachers towards mathematical modeling. Considering that teachers with higher academic degrees exhibit more positive attitudes towards mathematical modeling, increasing the educational levels of teachers and providing graduate education opportunities to improve mathematics education could be an important strategy. In this context, encouraging and supporting participation in master's programs with thesis, as well as opening courses related to mathematical modeling at the graduate level or conducting studies in that direction, is important as it would have greater reflections on educational activities. It has been determined that theses on mathematical modeling are being prepared at the graduate and doctoral levels (Albayrak &

Çiltaş, 2017; Saka, 2023; Yenilmez & Yıldız, 2019), and it is seen that mathematics teachers are conducting studies to gain expertise in modeling. It is inevitable that this situation will have reflections in the educational environment.

Finally, it has been concluded that there is no significant difference in the attitude levels towards mathematical modeling among teachers with different levels of professional seniority. It has been observed that as teachers' professional seniority increases, their attitudes towards mathematical modeling do not change and remain at a similar level. It will be important to organize professional development programs for teachers to renew their knowledge and skills in mathematical modeling and to encourage the participation of teachers with professional seniority in these programs to keep up with current developments.

Within the scope of the current research, the following recommendations can be made: Mathematics education programs should provide comprehensive education on mathematical modeling for teacher candidates and emphasize awareness-raising activities in this regard. These training sessions should include activities that will strengthen the mathematical modeling skills of teacher candidates. Continuous professional development opportunities should be offered to support the professional development of teachers; these opportunities will allow them to update and improve their knowledge and skills regarding mathematical modeling. Additionally, encouraging policies should be implemented to increase teachers' access to graduate education opportunities, considering that teachers with a master's degree have higher attitudes towards mathematical modeling. Future research should consider other factors related to attitudes towards mathematical modeling and conduct a more comprehensive analysis. This can help us better understand the attitudes of teachers in mathematics education and the factors affecting these attitudes, and shape educational policies accordingly.

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Conflict of Interest

The authors declare that there is no conflict of interest. The authors contributed equally to the study.

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Ethical Standards

The permission of this research was approved by decision number 4 of meeting number 10 of the ethics committee of Adnan Menderes University held on 01.12.2023. Data were collected with the permission of the scale owners. However, volunteer teachers working in public schools participated in the research.

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