

Investigation of pre-service Mathematics teachers' instructional competencies in ChatGPT-supported lesson planning process

Ayşe Tuğçe Bodur ^{a*} , Mevhibe Kobak Demir ^a 

^a Balıkesir University, Türkiye.

Suggested citation: Bodur, A. T. & Kobak Demir, M (2025). Investigation of pre-service Mathematics teachers' instructional competencies in ChatGPT-supported lesson planning process. *Journal of Educational Technology and Online Learning*, 8(4), 394-408

Highlights

- Descriptive findings indicated a decrease in mathematics teaching efficacy (MTES) and outcome expectations, while a slight upward trend was observed in the self-efficacy sub-dimension.
- Mathematics teaching anxiety (MTAS) showed a decreasing trend across total score, subject knowledge, self-confidence, pedagogical knowledge, and teaching attitude dimensions.
- Teaching process self-efficacy (SB-TPS) scores demonstrated an increase in planning and implementation dimensions, whereas a decrease was observed in the evaluation dimension.

Abstract

In today's world, where digitalization in education is gaining momentum, it is important to investigate the impact of AI-supported lesson planning on teacher competencies. The purpose of this study is to analyze the effect of ChatGPT-supported lesson planning on the instructional competency scores of pre-service mathematics teachers. A one-group pre-test-post-test experimental design was employed. The study group consisted of 17 third-year pre-service secondary school mathematics teachers from a state university in western Türkiye, selected via criterion sampling. Data were collected using three instruments: the Mathematics Teaching Efficacy Scale (MTES), the Mathematics Teaching Anxiety Scale (MTAS), and the Self-Efficacy Beliefs Regarding the Teaching Process Scale (SB-TPS). The data were analyzed using SPSS 20.0, following normality tests. Results indicated a decrease in the total scores for mathematics teaching competencies and mathematics teaching anxiety, while an increasing trend was observed in self-efficacy beliefs regarding the teaching process; however, these changes were not statistically significant. This study represents an initial step, highlighting the need for further research to advance a comprehensive understanding of AI integration in teacher education.

Article Info: Research Article

Keywords: *Mathematics education, ChatGPT, lesson planning, pre-service teachers, instructional competency*

1. Introduction

The quality of teaching is integral to providing high-quality education, which is essential for a society to progress and for developing countries to achieve high life standards (Şahinkaya, 2008). An effective learning environment and teaching process can only be provided by professionally well-trained teachers (Öztürk, et al., 2022). This facilitates the effective delivery of instruction, prevents potential problems during the process, and leads to successful outcomes (Sırmacı & Konyalıoğlu, 2021).

To ensure this professional training, microteaching is frequently employed as a teacher training technique in educational research (Allen & Ryan, 1969; Remesh, 2013). Microteaching is a teaching technique that can be applied to very small lessons or a single concept with fewer students, reducing the complexity of

* Corresponding author. Balıkesir University, Türkiye.

e-mail address: aysetugcebodur@hotmail.com

This study was partly presented as a proceeding at the 5th International Conference on Educational Technology and Online Learning held between 26-29 August 2025.

real teaching by allowing for immediate feedback after the application (Remesh, 2013). This technique helps reduce pre-service teachers' fear of making mistakes to a minimum, thereby contributing to the development of their self-confidence (as cited in Kaleli-Yılmaz & Ergün, 2017). Even if pre-service teachers are well-equipped with theoretical knowledge, they may experience negative emotions such as anxiety, fear, and worry when they enter a real classroom environment (Yıldız, 2022). Microteaching enables them to bridge the gap between theoretical knowledge and practical application (Allsopp et al., 2006), helping them develop skills in capturing attention, asking questions, and classroom management (Kılıç, 2010). Although microteaching provides a safe practice environment, the efficacy of this process heavily relies on robust lesson planning. As in many fields, planning plays a crucial role in education (Yeşilyurt, 2021). Instructional success is generally low when left to chance without proper planning (Çelik & Önal, 2005). However, creating detailed and creative lesson plans can be challenging for novice teachers. The importance of educational quality and the complexity of planning have made the integration of Artificial Intelligence (AI) inevitable (Keskin & Seveli, 2024). AI technologies are increasingly being integrated into educational environments, encompassing not only in-class applications but also the process of preparing teaching plans. The integration of AI in education provides numerous benefits. Teachers' awareness of artificial intelligence requires developing their ability to use it effectively and to use it safely and effectively while adhering to ethical principles and values (Çayak, 2024). Recent bibliometric studies also highlight that AI is playing a transformative role in teaching and learning processes, creating new trends in educational research (Durak et al., 2024). It can identify deficiencies in educational materials that teachers might overlook and pinpoint topics requiring improvement (Temur, 2024). Artificial intelligence-based automatic grading systems can evaluate students' work quickly and accurately, providing instant feedback and reducing teachers' workload (Eke, 2024). Moreover, recent reviews highlight that AI tools are reshaping online assessment strategies by offering new possibilities for formative evaluation and personalized feedback mechanisms (Karadağ, 2023). It can also enhance teachers' instructional methods and improve the quality of teacher training (Jamal, 2023). AI offers teachers the opportunity to identify their strengths and systematize collaboration strategies to maximize the skills of the teaching staff (Yuskovych-Zhukovska et al., 2022). It can personalize the learning process by creating content based on students' learning speeds, individual skills, and interests (Boztepe, 2025). An efficient learning process is ensured by accurately identifying individual needs (Orak & Turan, 2024).

AI exhibits similar capabilities in lesson planning, a crucial stage of instructional design (Karaman & Goksu, 2024). The use of AI in this area can be a fundamental step, especially for pre-service teachers who have less teaching experience and pedagogical knowledge (Farrokhnia et al., 2023). To realize these benefits, selecting the right AI tool is crucial. One such tool suitable for educational purposes is ChatGPT (Sok & Heng, 2023), which has rapidly gained popularity due to its ability to perform complex tasks (Tapan-Broutin, 2024). ChatGPT is a leading AI tool in education, used for writing articles, summarizing texts, answering questions, language translation, grammar correction, and encouraging class participation through interactive games (Sok, 2023). However, the academic community approaches these tools with caution; while acknowledging benefits like time-saving and editing support, there are significant concerns regarding academic honesty and ethical usage (Durak & Çankaya, 2024). Despite its widespread use, its potential for a more effective role in educational settings and how students utilize it remain largely unexplored (Jo, 2024). The integration of AI is particularly significant in mathematics education, as it offers tools to concretize abstract concepts, develop individualized teaching methods, and provide continuous feedback (Kara, 2024). AI systems can provide concepts and methods designed for teaching and learning purposes (Çelik-Görgüt, 2023), thereby improving teaching quality and creating better learning experiences compared to traditional methods (Nayiroğlu & Tutak, 2024). However, the effective use of these technologies depends on teachers' subject knowledge and self-confidence (Demir & Beyazhançer, 2024). Similarly, studies focusing on pre-service science and mathematics teachers emphasize that integrating technology into teaching practices within the TPACK framework is essential for developing their professional competencies and online teaching experiences (Kocagül & Ünal Çoban, 2024). This is where the importance of teacher training becomes evident. Instructors training pre-service teachers can utilize AI tools to help students reason, solve problems, and make judgments (Duralar, 2024). Specifically, lesson

planning is a critical competency where AI can play a transformative role. Lesson plans prepared using AI tools help pre-service mathematics teachers create more consistent and pedagogically sound plans (Holmes, Bialik & Fadel, 2019; Luckin et al., 2016). This support system is crucial for the variables examined in this study. Since mathematics teaching anxiety negatively affects teaching behaviors (Peker, 2009b), AI's ability to reduce cognitive load during planning may mitigate this anxiety. Furthermore, as teaching competence reflects the ability to plan and implement instruction effectively (Shulman, 1986), AI-supported planning can directly scaffold this skill. Consequently, successful planning experiences can bolster self-efficacy beliefs, which are central to instructional decision-making and persistence (Bandura, 1997). Examining these dimensions together helps us understand how AI-supported lesson planning contributes to the professional development of pre-service mathematics teachers. Therefore, this study investigates the effect of ChatGPT-supported lesson planning on the teaching efficacy, anxiety, and skill-based teaching beliefs of pre-service mathematics teachers. In line with this aim, the following research questions guide this study:

- Is there a significant difference between the pre-test and post-test scores of pre-service teachers' mathematics teaching competency levels?
- Is there a significant difference between pre-test and post-test scores in pre-service teachers' anxiety levels regarding mathematics teaching?
- Is there a significant difference between pre-test and post-test scores in pre-service teachers' self-efficacy beliefs regarding the teaching process?

In line with the research purpose, the following hypotheses were tested in the study:

H₁: There is a statistically significant difference between the pre-test and post-test mathematics teaching competency scores of pre-service teachers.

H₂: There is a statistically significant difference between the pre-test and post-test mathematics teaching anxiety scores of pre-service teachers.

H₃: There is a statistically significant difference between the pre-test and post-test self-efficacy belief scores regarding the teaching process of pre-service teachers.

2. Literature

Mathematics Teaching Efficacy Scale (MTES)

Bandura states that self-efficacy depends on experiences requiring expertise and on vicarious experiences (Hacıömeroğlu & Şahin-Taşkın, 2010). Teacher self-efficacy is teachers' belief in their ability to influence student performance (as cited in Dinçer et al., 2016). During the teaching and learning process, a teacher's perception of competence relates to the concepts of self-efficacy and outcome expectancy (Deringöl, 2018). Self-efficacy is the faith in one's own ability to teach effectively (Enochs et al., 2000), while outcome expectancy is the faith that effective instruction can be delivered to students regardless of external factors (Swars et al., 2007). Mathematics teaching competence is a person's ability to teach mathematics effectively (as cited in Giles et al., 2016). Effective mathematics teaching depends on the teacher's perspective on their profession, their sense of competence in their field, and their behavior towards students (Pul & Aksu, 2020). If teachers' perceptions of competence are high, it is believed that they will be more confident while teaching mathematics (Esendemir et al., 2015). It is important for teachers to feel competent in their field, and examining their self-efficacy beliefs and taking precautions against possible situations will contribute to improving the quality of education (Pul & Aksu, 2020).

The literature contains numerous studies on mathematics teaching competence across various fields and research groups. For instance, while studies by Gözel and Toptaş (2017) and Zehir et al. (2019) found no significant gender-based differences in this area, Hendricks et al. (2024) concluded that female pre-service teachers had higher competence levels than their male counterparts. Regarding its effect on student outcomes, Segarra and Julia (2022) found that pre-service teachers' mathematics teaching proficiency moderately affects academic achievement, whereas Gulistan et al. (2017) reported a high impact. Furthermore, research by Briley (2012) and Lau (2022) revealed a positive correlation between the level of mathematics teaching competence and self-efficacy beliefs.

Mathematics Teaching Anxiety Scale (MTAS)

Math anxiety is often cited as a significant factor that negatively affects an individual's success in mathematics (Bindak, 2005). It has been defined as “a temporary anxiety about numbers consisting of emotional reactions to arithmetic and mathematics” (Dreger & Aiken, 1957) and as “a feeling of tension and anxiety that hinders the manipulation of numbers and the solution of mathematical problems” (Richardson & Suinn, 1972). Building on this concept, Peker (2009a) defines mathematics teaching anxiety as “the feeling of tension or anxiety experienced by pre-service teachers or teachers when teaching mathematical concepts, theories, or formulas or during the problem-solving process”. This type of anxiety is not exclusive to those with a weak mathematics background; it can also affect individuals who possess strong mathematical knowledge but lack confidence in their teaching abilities (Brown et al., 2011). Teacher training institutions play an important role in reducing pre-service teachers' beliefs and anxieties about mathematics, which will be effective in mathematics teaching (Peker & Ertekin, 2011).

Although these two concepts are related, they are distinct constructs. While mathematics anxiety refers to the tension experienced by an individual during the manipulation of numbers and problem-solving, mathematics teaching anxiety specifically concerns the anxiety associated with the pedagogical process of explaining mathematical concepts to others. As Brown et al. (2011) highlight, teaching anxiety is not limited to those with weak mathematical content knowledge; it can also affect individuals who are proficient in mathematics but lack self-confidence in their pedagogical abilities. Therefore, an individual may have low mathematics anxiety but high mathematics teaching anxiety, or vice versa (Patkin & Greenstein, 2020). The research on factors related to mathematics teaching anxiety shows varied findings. For instance, the association between metacognitive consciousness and mathematics teaching anxiety has yielded conflicting results; Kaçar and Sarıçam (2015) found a significant negative correlation, while Öztürk and Serin (2020) reported a significant positive correlation. In terms of interventions, technology like GeoGebra has been shown to be effective. Studies by Zengin (2017) with pre-service teachers and Tüzer-Ünsal and Akay (2020) with 10th-grade students both found a decrease in mathematics anxiety after using the software. Furthermore, the connection between personal math anxiety and math teaching anxiety is complex. In a study of three pre-service teachers, Olson and Stoehr (2019) suggested that individuals with a history of math anxiety might also experience math teaching anxiety. Conversely, Patkin and Greenstein (2020) found in their study of 18 pre-service teachers that high levels of personal math anxiety didn't necessarily translate to high anxiety when teaching.

Self-Efficacy Beliefs Regarding the Teaching Process Scale (SB-TPS)

The attitudes, values, and judgments of mathematics teachers can impact the evolution of their students' self-efficacy beliefs, a crucial aspect of learning that extends beyond mere competence (Yerlikaya & Takunyacı, 2020). Batar and Aydın (2014) define self-efficacy as “a person's awareness of what they can do and their ability to find the strength to fight against what they cannot do, which is related to how they see and feel about themselves”. In the teaching context, teacher self-efficacy is associated with both teacher effectiveness and instructional quality (Demirtaş et al., 2011). Furthermore, high self-efficacy beliefs among teachers and pre-service teachers are linked to enhanced student motivation and success, improved classroom management, and more effective planning, implementation, and evaluation activities (Özdemir, 2008).

Studies have explored self-efficacy beliefs in various educational contexts. For instance, Çiftçi and Topçu (2022) researched the effect of STEM education integrated with scientific thinking on the self-efficacy beliefs of preschool pre-service teachers in that domain. Their study found that the integrated approach had a greater effect than STEM education alone. The association between self-efficacy in mathematics teaching and mathematics anxiety has yielded mixed results; Doruk and Kaplan (2012) found no significant relationship, while Gorospe (2022) reported one. In another area, Birisci and Kul (2019) examined teacher candidates and found a high correlation between self-efficacy beliefs for technology integration and the level of technological pedagogical educational competence.

A review of the literature revealed two primary gaps that this study aims to address. First, no studies were found that examined the effects of artificial intelligence on mathematics teaching competence, mathematics teaching anxiety, and self-efficacy beliefs in the teaching process. Second, there appears to be a lack of intervention-based research using a pre-test-post-test design to investigate changes in mathematics teaching anxiety.

3. Methodology

3.1. Research Model/Design

The study employed a quantitative research method, focusing on the collection and analysis of quantitative data (Özdemir & Dođruöz, 2020). A pre-test post-test experimental design without a control group was used in the study.

3.2. Data Collection Tools

In the study, a total of three scales were used to analyze the impact of using ChatGPT on mathematics pre-service teachers' instructional competency scores:

MTES: The scale, developed for mathematics education by Enochs et al. (2000) and adapted into Turkish by Şahinkaya (2008), is a 5-point Likert scale. The scale consists of two dimensions—the self-efficacy and the outcome expectation—and 21 items. The Cronbach Alpha coefficient was calculated as .88 for the self-efficacy dimension and .77 for the outcome expectation dimension.

MTAS: The scale developed by Peker (2006) consists of a total of 23 items on a 5-point Likert scale with 4 factors. The Cronbach Alpha coefficient was .91 for the total score of the scale, .90 for the factor of pre-service teachers' subject knowledge in mathematics teaching anxiety (PT-SKMTA), .83 for the factor of pre-service teachers' self-confidence in mathematics teaching anxiety (PT-SCMTA), .71 for the factor pre-service teachers' attitudes toward teaching mathematics in mathematics teaching anxiety (PT-AMTA), and the factor of pre-service teachers' subject education knowledge in anxiety towards teaching mathematics (PT-SEKA) was .61.

SB-TPS: The scale developed by Özdemir (2008) using a 5-point Likert scale consists of 40 items covering the dimensions of planning, implementation, and evaluation. The Cronbach Alpha coefficient of the scale was calculated as .882 for the total score, .668 for the planning dimension, .839 for the implementation dimension, and .756 for the evaluation dimension.

The study was approved on 13.01.2025 by the Ethics Committee of Balıkesir University (approval number E-16031472-108.01-472813).

3.3. Study Group

The study participants were 17 pre-service teachers, including 9 females and 8 males, studying in the third year of the Mathematics Education Department at a state university located in western Türkiye during the 2024-2025 academic year. For the aim of the research, criterion sampling was used as the sampling method. The criteria were that the pre-service teachers had completed the courses “Algorithms and Programming,” “High School Mathematics Teaching Programs,” and “Teaching Technologies” during their undergraduate education.

3.4. Data Analysis

The data were analyzed using the SPSS 20.0 software package. Since the group size was less than 50, the Shapiro-Wilk test (Büyüköztürk, 2023) was applied to the 17 pre-service teachers participating in the study after performing a normality analysis. Total analyses were performed at a significance level of $p=.05$.

From the scales: MTES total score and self-efficacy subscale, MTAS total score, mathematics teaching anxiety in pre-service teachers' subject knowledge, the self-confidence dimension of pre-service teachers' anxiety towards teaching mathematics, the subject education knowledge dimension of pre-service teachers' anxiety towards teaching mathematics, and the evaluation dimension of SB-TPS showed a normal

distribution ($p > .05$). MTES sub-dimension of expected results, MTAS sub-dimension of pre-service teachers' attitudes towards teaching mathematics, and the total score of SB-TPS, planning and implementation sub-dimension pre-test and post-test scores did not show a normal distribution ($p < .05$). Therefore, the Paired Samples T-Test from parametric tests was used for scales and sub-dimensions showing a normal distribution ($p > .05$), and the Wilcoxon Signed-Rank Test from non-parametric tests was used for scales and sub-dimensions not showing a normal distribution ($p < .05$).

Cohen's d effect sizes were calculated to determine the practical significance of the findings. The analysis yielded small effect sizes for MTES ($d = 0.01$) and SB-TPS ($d = 0.25$). For the MTAS scale, a small negative effect size was observed ($d = 0.28$), indicating a decrease in anxiety levels following the intervention.

3.5. Validity and Reliability

Cronbach's alpha coefficients were calculated to assess the internal consistency of the scales used in the study. The coefficients for the MTAS (Pre-test: .91, Post-test: .94) and SB-TPS (Pre-test: .94, Post-test: .96) indicated high reliability. However, the reliability coefficients for the MTES were found to be relatively low (Pre-test: .44, Post-test: .53). The implications of the lower reliability for MTES are addressed in the limitations section.

3.6. Research Procedures

The experimental process covered a total of 32 lesson hours. In the first session, the MTES, MTAS, and SB-TPS scales were administered to the pre-service teachers as a pre-test. Following the data collection, a 5-hour theoretical training was provided, covering the history of artificial intelligence, the use of AI tools (specifically ChatGPT versions 3.5, 4, and 4o), the development of self-assessment rubrics, and the 5E Model lesson plan structure. After the training phase, the pre-service teachers were given three lesson hours to develop a self-assessment rubric and a lesson plan based on the 5E Learning Model, utilizing ChatGPT as an assistant. The participants selected the grade levels and themes for their lesson plans independently. The implementation phase involved microteaching sessions spanning 19 lesson hours, where each pre-service teacher was allocated 40 minutes to present their lesson. To ensure a standardized evaluation and control the process effectively, the microteaching sessions were assessed by the researchers using a specific "Process Evaluation Form." This form was developed with the assistance of ChatGPT and reviewed by experts for content validity. It included structured criteria focusing on subject knowledge, pedagogical content knowledge, classroom management, and communication skills, aligned with each stage of the 5E model. Items were scored on a 5-point Likert scale. Simultaneously, pre-service teachers evaluated their own performance using the self-evaluation rubrics they had generated with ChatGPT. To standardise the microteaching process and minimise the potential random variability associated with solitary practice, a structured AI-Feedback Loop mechanism was implemented. To integrate the AI-based feedback loop, the researchers' evaluation forms, the students' self-evaluation forms, and the initial lesson plans were input into ChatGPT. In this mechanism, the microteaching sessions were not treated solely as repetitive practice; instead, they were guided by systematic, criteria-based feedback generated by both ChatGPT and the researchers. This approach aimed to ensure that the participants' development was driven by the cognitive integration of the 5E model and AI tools, rather than just behavioral repetition. The AI model provided specific feedback for improvement. Based on this feedback from both ChatGPT and the researchers, the pre-service teachers revised and reorganized their lesson plans. Finally, in the last session, the scales used in the pre-test were re-administered as a post-test to measure the changes.

4. Results

The T-test findings for the MTES total score and self-efficacy sub-dimension administered to mathematics pre-service teachers are presented in Table 1.

Table 1.

T-test results for MTES total scores and self-efficacy sub-dimension

Variable	Measurement	<i>N</i>	<i>M</i>	<i>SD</i>	<i>df</i>	<i>t</i>	<i>p</i>	Cohen's <i>d</i>
MTES	Pre-test	17	73.58	5.52	16	.04	.970	0.01
Total	Post-test	17	73.52	5.03				
Self-Efficacy	Pre-test	17	50.88	5.79	16	-.04	.965	0.01
(Sub-dimension)	Post-test	17	50.94	4.05				

Table 1 shows the comparison of pre-test and post-test scores. The analysis revealed no statistically significant difference between the pre-test and post-test scores for both the MTES Total score ($t(16) = 0.04, p > .05$) and the Self-Efficacy sub-dimension ($t(16) = -0.04, p > .05$). The effect sizes were found to be negligible ($d = 0.01$).

The findings of the Wilcoxon Signed-Rank Test for the expectation sub-dimension of the MTES are presented in Table 2.

Table 2.

Results of the Wilcoxon Signed-Rank test for the outcome expectation subscale

Groups	<i>n</i>	Mean Rank	Sum of Ranks	<i>z</i>	<i>p</i>	Effect size (<i>r</i>)
Negative Ranks	8	8.44	67.50	-0.44	.663	0.11
Positive Ranks	7	7.50	52.50			
Ties	2	-	-			
Total	17					

Note. Based on negative ranks.

The Wilcoxon Signed-Rank Test results indicated no statistically significant difference between the pre-test and post-test scores of the Outcome Expectation sub-dimension ($z = -0.44, p > .05$). The calculation revealed a small effect size ($r = 0.11$), suggesting that the intervention did not lead to a meaningful change in outcome expectations.

A paired samples t-test was conducted to examine the changes in pre-service teachers' mathematics teaching anxiety levels (MTAS) and its sub-dimensions. The results are presented in Table 3.

Table 3.

T-test results for MTAS total scores and dimensions

Variable	Measurement	<i>N</i>	<i>M</i>	<i>SD</i>	<i>df</i>	<i>t</i>	<i>p</i>	Cohen's <i>d</i>
MTAS	Pre-test	17	45.00	10.31	16	1.15	.270	0.28
Total	Post-test	17	43.00	12.03				
PT-SKMTA	Pre-test	17	18.29	5.43	16	0.60	.560	0.15
(Sub-dimension)	Post-test	17	17.76	5.72				
PT-SCMTA	Pre-test	17	14.53	4.03	16	1.38	.190	0.33
(Sub-dimension)	Post-test	17	13.59	4.39				
PT-SEKA	Pre-test	17	5.65	1.50	16	1.00	.330	0.24
(Sub-dimension)	Post-test	17	5.29	1.80				

Note: PT-SKMTA: Subject Knowledge in Mathematics Teaching Anxiety; PT-SCMTA: Self-Confidence in Mathematics Teaching Anxiety; PT-SEKA: Subject Education Knowledge in Anxiety Towards Teaching Mathematics.

The results of the paired samples t-test indicated no statistically significant difference between the pre-test and post-test scores for the total MTAS ($t(16) = 1.15, p > .05$) nor for any of its sub-dimensions. Although a decrease in mean scores was observed across all dimensions, the effect sizes were found to be

small (ranging from $d = 0.15$ to $d = 0.33$), suggesting that the intervention did not result in a statistically significant reduction in teaching anxiety within this sample group.

The Wilcoxon Signed-Rank Test results for the PT-AMTA sub-dimension are presented in Table 4.

Table 4.

Results of the Wilcoxon Signed-Rank Test for PT-AMTA

Groups	<i>n</i>	Mean Rank	Sum of Ranks	<i>z</i>	<i>p</i>	Effect size (<i>r</i>)
Negative Ranks	6	6.92	41.50	-0.020	.840	0.05
Positive Ranks	6	6.08	36.50			
Ties	5	-	-			
Total	17					

Note: Based on negative ranks. PT-AMTA: Attitudes Toward Teaching Mathematics in Mathematics Teaching Anxiety.

The analysis showed no statistically significant difference between the pre-test and post-test scores ($z = -0.20, p > .05$). The effect size was negligible ($r = .05$), indicating that the intervention had no observable impact on this specific dimension of anxiety.

The results of the Wilcoxon Signed-Rank Test for the total score and the planning and implementation dimensions of SB-TPS, as measured by the SB-TPS administered to pre-service teachers, are provided in Table 5.

Table 5.

SB-TPS total score and dimensions related to the teaching process: Wilcoxon Signed-Rank Test Results

Variable	Groups	<i>n</i>	Mean Rank	Sum of Ranks	<i>z</i>	<i>p</i>	Effect size (<i>r</i>)
SB-TPS Total Score	Negative Ranks	5	11.00	55.00	-1.02	.310	0.25
	Positive Ranks	12	8.17	98.00			
	Ties	0	-	-			
Planning (Dimension)	Negative Ranks	5	5.90	29.50	-1.45	.150	0.35
	Positive Ranks	9	8.39	75.50			
	Ties	3	-	-			
Implementation (Dimension)	Negative Ranks	5	7.80	39.00	-1.50	.130	0.36
	Positive Ranks	11	8.82	97.00			
	Ties	1	-	-			

Note. Based on negative ranks.

Although the number of participants with increased post-test scores (Positive Ranks) was higher than those with decreased scores across all dimensions, the analysis revealed no statistically significant difference between pre-test and post-test scores for the Total Score ($z = -1.02, p > .05$), Planning Dimension ($z = -1.45, p > .05$), or Implementation Dimension ($z = -1.50, p > .05$). However, the calculated effect sizes were small-to-medium (*r* values ranging from .25 to .36), suggesting a potential positive trend that was not statistically significant due to the sample size.

The T-test results for the evaluation dimension for related samples are provided in Table 6.

Table 6.

T-test results for evaluation dimension

Variable	Measurement	<i>N</i>	<i>M</i>	<i>SD</i>	<i>df</i>	<i>t</i>	<i>p</i>	Cohen's <i>d</i>
Evaluation (Dimension)	Pre-test	17	52.59	4.69	16	0.37	.716	0.09
	Post-test	17	52.06	6.11				

The analysis indicated no statistically significant difference between the pre-test ($M = 52.59$) and post-test ($M = 52.06$) scores ($t(16) = 0.37, p > .05$). The calculated effect size ($d = 0.09$) confirmed that the intervention had a negligible effect on the participants' evaluation skills scores.

5. Conclusion, Discussions and Suggestions

The purpose of this study is to analyze the effect of ChatGPT-supported lesson planning on the instructional competence scores of prospective mathematics teachers.

The findings showed that there was a decrease in the MTES total score and the mean value of the outcome expectation sub-dimension, while there was an increase in the mean value of self-efficacy; however, these increases and decreases were not statistically significant. Although not statistically significant, the slight upward trend in the self-efficacy sub-dimension may suggest that the practical experience of preparing and implementing AI-supported plans provided a source of mastery experience, potentially supporting their belief in their personal teaching capabilities. These results differ from some previous research. For example, Utley et al. (2010), in a study where pre-service teachers used concrete materials to teach children, found a significant increase in both self-efficacy and outcome expectancy dimensions, which contrasts with the non-significant findings of the current study. Similarly, the findings differ from those of Tertemiz and Şahinkaya (2010), who reported that a project-based teaching approach led to a significant increase in overall mathematics teaching competence, whereas an activity-based approach did not. However, the results are partially aligned with Özpınar's (2021) study, which also found a significant increase in the total score and self-efficacy dimension but no significant change in the outcome expectation dimension.

Regarding pre-service teachers' MTAS, a non-statistically significant decrease was observed in the total score and across all its sub-dimensions (subject knowledge, self-confidence, subject teaching knowledge, and attitudes). Many studies have examined the relationship between anxiety about teaching mathematics and mathematics teaching competence (McMinn & Aldridge, 2020; Çelik, 2021), mathematics anxiety (Hacıomeroglu, 2014; Serin, 2017), and self-efficacy beliefs (Unlu et al., 2017; Ozben & Kilicoglu, 2021). In line with the findings of the present study, Tatar et al. (2015), Yavuz et al. (2018), and Yazlık & Çetin (2020) reported that pre-service teachers had low levels of anxiety about teaching mathematics. In contrast, other studies by Çenberci (2019) and Bal (2020) concluded that pre-service teachers' anxiety levels were moderate, which differs from the low levels observed here.

When examining SB-TPS, the results showed a non-statistically significant increase in the total score, planning, and implementation dimensions, alongside a non-significant decrease in the evaluation dimension. This finding contrasts with the work of Kurt and Ekici (2013), who reported a statistically significant decrease in self-efficacy related to the teaching process. The results are also partially different from those of Kurt et al. (2014), who found a non-significant increase in both the total score and its sub-dimensions. A plausible explanation for the increase in the planning and implementation dimensions in the current study can be attributed to the hands-on experience of the pre-service teachers preparing and implementing their own lesson plans.

Although the descriptive statistics indicated slight changes in mean scores across various dimensions, the inferential analyses (t-tests and Wilcoxon signed-rank tests) revealed no statistically significant differences between the pre-test and post-test scores for MTES, MTAS, and SB-TPS scales ($p > .05$). Several factors may explain these non-significant findings. First, the sample size ($N=17$) was relatively small, which limits the statistical power of the study to detect small or medium effects. As noted in the results, effect sizes (Cohen's d and r) were generally small-to-medium, suggesting that a larger sample might have yielded

different statistical outcomes. Second, constructs such as teaching efficacy, anxiety, and skill-based beliefs are deeply rooted affective traits that typically require longitudinal interventions to undergo significant transformation. The duration of the microteaching process, while intensive, may not have been sufficient to radically alter these stable psychological constructs. As suggested by Durak et al. (2025), the adoption of GenAI is a longitudinal process where structured training significantly influences skill development over time; thus, extended interventions might be necessary for deeper competency gains. Finally, the introduction of advanced AI tools (ChatGPT) might have initially imposed an additional cognitive load on pre-service teachers, potentially offsetting the immediate gains in confidence and anxiety reduction. Therefore, these quantitative results should be interpreted as a pilot indicator, highlighting the need for longer-term studies with larger cohorts to fully explore the impact of AI-supported microteaching.

Another critical factor to consider in interpreting the findings is the variability in the ChatGPT versions (3.5, 4, 4o, and 4.5) utilized by the participants. It is well-documented that advanced versions like GPT-4 and GPT-4o possess superior reasoning capabilities, multimodal processing, and context adherence compared to the base model GPT-3.5. This disparity implies that participants using advanced versions may have received higher-quality feedback and more structured lesson plans, potentially creating an uneven support mechanism within the experimental group. From a methodological standpoint, this lack of standardization introduces a confounding variable that may have increased the variance in the outcome measures (MTES, MTAS, SB-TPS), contributing to the non-significant statistical results observed in this study. However, from the perspective of ecological validity, this heterogeneity mirrors the current educational landscape, where teachers' access to paid or free AI tools varies significantly due to economic or institutional factors.

This research has several limitations that suggest directions for future research. First, the study was limited to the use of a single artificial intelligence application and involved various versions of ChatGPT, which may have influenced the results. Future research could, therefore, investigate the effects of using a single, fixed version of an AI tool or compare the impact of multiple different AI applications. Additionally, the participants were pre-service teachers not yet in their official teaching practice. Future studies could explore the experiences of those undergoing their practicum, as the real-world application of these skills might yield more significant changes on the competency scales. Finally, expanding the research to include in-service teachers from various disciplines would provide a broader perspective. Incorporating qualitative data, such as interviews or focus groups, would also allow for a more detailed examination of the underlying reasons for the quantitative findings reported in this study. Although the Cronbach's alpha values for the MTES scale were lower than the generally accepted threshold of .70, this scale was retained in the analysis to provide a holistic view of mathematics teaching efficacy beliefs. The low reliability may be attributed to the small sample size or the broad and multidimensional nature of the construct being measured, and results related to MTES should be interpreted with caution. Finally, the sample size of this study consisted of a relatively small group of teacher candidates. Therefore, the findings obtained from this study may not be generalisable to the wider population. The results should be interpreted as reflecting the specific characteristics of this participant group, and future studies with larger samples are recommended to validate these findings.

Acknowledgments

This study, derived from the first author's master's thesis supervised by the second author, was supported by the Scientific Research Projects Coordination Unit of Balıkesir University (Project Number: 2025/043). A preliminary version was presented at the 5th International Conference on Educational Technology and Online Learning (26–29 August 2025).

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used AI in order to improve the readability and language of the manuscript. The authors reviewed and edited the content as needed and take full responsibility for the content of the publication. Furthermore, as detailed in the methodology section of this study, generative AI

(ChatGPT versions 3.5, 4, 4o, and 4.5) served as the primary independent variable and pedagogical tool utilized by the pre-service teachers for lesson planning within the scope of the experimental design.

References

- Allen, D. W., & Ryan, K. (1969). *Microteaching*. Reading, MA: Addison-Wesley.
- Allsopp, D. H., DeMarie, D., Alvarez-McHatton, P. & Doone, E. (2006). Bridging the gap between theory and practice: Connecting courses with field experience. *Teacher Education Quarterly* 33(1), 19-35.
- Bal, A. P. (2020). Investigation of attitude and anxiety levels of primary school undergraduate students about mathematics teaching. *Bolu Abant İzzet Baysal University Journal of Faculty of Education*, 20(4), 1608-1622. <https://dx.doi.org/10.17240/aibuefd.2020.20.58249-613284>
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. W.H. Freeman and Company.
- Batar, M., & Aydın, İ. S. (2014). Evaluation of Turkish teacher candidates' self- efficacy beliefs of written expression. *International Journal of Language Academy*, 2(4), 579-598.
- Bindak, R. (2005). Math anxiety scale for elementary school students. *Science and Engineering Journal of Firat University*, 17(2), 442-448.
- Birisci, S., & Kul, U. (2019). Predictors of technology integration self-efficacy beliefs of preservice teachers. *Contemporary Educational Technology*, 10(1), 75-93. <https://doi.org/10.30935/cet.512537>
- Boztepe, C. (2025). Artificial intelligence applications in education: opportunities, limitations, and ethical debates. *Dumlupınar University Graduate School of Education Journal*, 9(1), 98-121. <https://doi.org/10.71272/debder.1706141>
- Briley, J. S. (2012). The relationships among mathematics teaching efficacy, mathematics self-efficacy, and mathematical beliefs for elementary pre-service teachers. *Issues in the Undergraduate Mathematics Preparation of School Teachers*, 5, 1-13.
- Brown, A. B., Westenskow, A., & Moyer-Packenham, P. S. (2011). Elementary pre-service teachers: can they experience mathematics teaching anxiety without having mathematics anxiety?. *Issues in the Undergraduate Mathematics Preparation of School Teachers*, 5, 1-14.
- Büyüköztürk, Ş. (2023). *Sosyal bilimler için veri analizi el kitabı istatistik, araştırma deseni Spss uygulamaları ve yorum*. Pegem Akademi.
- Çayak, S. (2024). Investigating the relationship between teachers' attitudes toward artificial intelligence and their artificial intelligence literacy. *Journal of Educational Technology and Online Learning*, 7(4), 367-383. <https://doi.org/10.31681/jetol.1490307>
- Çelik, F., & Önal, A. S. (2005). Öğretimde planlama ve değerlendirme dersi öğretim programının değerlendirilmesi. *Pamukkale University Journal of Education*, 18(18), 31-49.
- Çelik, M. (2021). Investigation of teacher candidates' teaching maths anxiety and teaching maths competencies. *International Journal of Progressive Education*, 17(6), 158-167. <https://doi.org/10.29329/ijpe.2021.382.11>
- Çelik-Görgüt, R. (2023). Yapay zeka ve matematik eğitimi. In A. Kuloğlu (Ed.) *Eğitim & Bilim IV* (pp. 43-60). Efe Akademi Yayınları.
- Çenberci, S. (2019). The examination of prospective mathematics teachers' mathematics teaching anxiety levels. *Journal of Theoretical Educational Sciences*, 12(4), 1193-1208. <https://doi.org/10.30831/akukeg.455708>
- Çiftçi, A., & Topçu, M. S. (2022). Improving early childhood pre-service teachers' computational thinking teaching self-efficacy beliefs in a STEM course. *Research in Science & Technological Education*, 41(4), 1215–1241. <https://doi.org/10.1080/02635143.2022.2036117>
- Demir, B., & Beyazhançer, R. (2024). Investigation of artificial intelligence self-efficacy of prospective elementary mathematics teachers in terms of some variables. *International Journal of Social and Humanities Sciences Research*, 11(113), 2393-2398. <https://doi.org/10.5281/zenodo.14279357>
- Demirtaş, H., Cömert, M., & Özer, N. (2011). Pre-service teachers' self-efficacy beliefs and attitudes towards profession. *Education and Science*, 36(159), 96-111.

- Deringöl, Y. (2018). An examination of the mathematics teaching efficacy and the mathematics teaching anxiety of classroom teacher candidates. *Journal of Theoretical Educational Science*, 11(2), 261-278. <http://dx.doi.org/10.30831/akukeg.364483>
- Dinçer, B., Akarsu, E. & Yılmaz, S. (2016). The investigation of perceptions of math literacy self-efficacy and mathematics teaching efficacy belief levels of preservice primary mathematics teachers. *Turkish Journal of Computer and Mathematics Education*, 7(1), 207-228.
- Doruk, M., & Kaplan, A. (2012). Examining prospective primary school teachers' self-efficacy beliefs toward mathematics teaching. *International Journal of Social Science*, 5(7), 291-302. https://doi.org/10.9761/jasss_250
- Dreger, R. M., and Aiken, L. R. (1957). The identification of number anxiety in a college population. *Journal of Educational Psychology*, 48(6), 344-351. <https://doi.org/10.1037/h0045894>
- Durak, G., & Çankaya, S. (2024). Are alarm bells ringing in academia? ChatGPT as a sample of using chatbots in education. *Turkish Online Journal of Distance Education*, 25(3), 1-17. <https://doi.org/10.17718/tojde.1353737>
- Durak, G., Çankaya, S., Esinbay, E., Yaman, H. E., Can, S., Özdemir, D., ... & İncemen, S. (2025). The critical role of structured training in GenAI adoption: A longitudinal case study on student perceptions and skills development. *International Journal of Technology and Design Education*, 1-26. <https://doi.org/10.1007/s10798-025-10025-y>
- Durak, G., Çankaya, S., Özdemir, D., & Can, S. (2024). Artificial intelligence in education: A bibliometric study on its role in transforming teaching and learning. *International Review of Research in Open and Distributed Learning*, 25(3), 219–244. <https://doi.org/10.19173/irrodl.v25i3.7757>
- Duralar, B. (2024). *Artificial intelligence research in mathematics education: A systematic review*. (Publication No. 875050) [Master's Thesis, Balıkesir University]. CoHE Thesis Center.
- Eke, O. E. (2024). Assessing the readiness and attitudes of Nigerian teacher educators towards adoption of artificial intelligence in educational settings. *Journal of Educational Technology and Online Learning*, 7(4), 473-487. <https://doi.org/10.31681/jetol.1503305>
- Enochs, L. G., Smith, P. L., & Huinker, D. A. (2000). Establishing factorial validity of the mathematics teaching efficacy beliefs instrument. *School Science and Mathematics*, 100(4), 194-202. <https://doi.org/10.1111/j.1949-8594.2000.tb17256.x>
- Esendemir, Ö., Çırak, S., & Samancıoğlu, M. (2015). Pre-service elementary math teachers' opinions about mathematics teaching competencies. *Gaziantep University Journal of Social Sciences*, 14(1), 217-239. <https://doi.org/10.21547/jss.256787>
- Farrokhnia, M., Banihashem, S. K., Noroozi, O., & Wals, A. (2023). A SWOT analysis of ChatGPT: Implications for educational practice and research. *Innovations in Education and Teaching International*, 61(3), 460–474. <https://doi.org/10.1080/14703297.2023.2195846>
- Giles, R. M., Byrd, K. O., & Bendolph, A. (2016). An investigation of elementary preservice teachers' self-efficacy for teaching mathematics. *Cogent Education*, 3(1). <https://doi.org/10.1080/2331186X.2016.1160523>
- Gorospe, J. D. (2022). Pre-service teachers' teaching anxiety, teaching self-efficacy, and problems encountered during the practice teaching course. *Journal of Education and Learning*, 11(4), 84-91. <https://doi.org/10.5539/jel.v11n4p84>
- Gözel, E., & Toptaş, V. (2017). The relationship between mathematical teaching efficacy beliefs and reflective thinking skills of pre-service primary school teachers. *Cumhuriyet International Journal of Education*, 6(4), 412-425. <https://doi.org/10.30703/cije.327172>
- Gulistan, M., Athar-Hussain, M., & Mushtaq, M. (2017). Relationship between mathematics teachers' self efficacy and students' academic achievement at secondary level. *Bulletin of Education and Research*, 39(3), 171-182.
- Hacımeroglu, G. (2014). Elementary pre-service teachers' mathematics anxiety and mathematics teaching anxiety. *International Journal for Mathematics Teaching and Learning*, 3, 1-10.
- Hacıömeroğlu, G., & Şahin-taşkın, Ç. (2010). Elementary preservice teachers' mathematics teaching efficacy belief. *Journal of Uludag University Faculty of Education*, 23(2), 539-555.

- Hendricks, W., Olawale, B.E., & Saddiq, K. (2024). An Investigation of high school preservice teachers' self-efficacy in teaching mathematics. *Education. Sciences.* 14(11), 1262. <https://doi.org/10.3390/educsci14111262>
- Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial intelligence in education: Promises and implications for teaching and learning*. Boston: Centre for Curriculum Redesign.
- Jamal, A. (2023). The role of artificial intelligence (AI) in teacher education: opportunities & challenges. *International Journal of Research and Analytical Reviews (IJRAR)*, 10(1), 139-146.
- Jo, H. (2024). From concerns to benefits: a comprehensive study of ChatGPT usage in education. *International Journal of Educational Technology in Higher Education*, 21(35), 2-29. <https://doi.org/10.1186/s41239-024-00471-4>
- Kacar, M., & Sarıçam, H. (2015). The examination of the relationship between metacognitive awareness and math anxiety levels in pre-service primary school teachers. *Trakya Journal of Education*, 5(2), 137-152.
- Kaleli Yılmaz, G., & Ergün, A. (2017). How does the level of technology usage of mathematics teacher candidates change with micro-teaching method? *Bayburt Eğitim Fakültesi Dergisi*, 12(24), 573-592.
- Kara, E. (2024). 21. Yüzyıl matematik eğitiminde yapay zekâ: teknolojik dönüşümde global stratejiler. *Çocuk ve Medeniyet*, 9(15), 8-43. <https://doi.org/10.47646/CMD.2024.334>
- Karadağ, N. (2023). The impact of artificial intelligence on online assessment: A preliminary review. *Journal of Educational Technology and Online Learning*, 6(4), 822-837. <https://doi.org/10.31681/jetol.1351548>
- Karaman, M.R. & Goksu, I. (2024). Are lesson plans created by ChatGPT more effective? An experimental study. *International Journal of Technology in Education (IJTE)*, 7(1), 107- 127. <https://doi.org/10.46328/ijte.607>
- Keskin, D., & Seveli, O. (2024). *Artificial intelligence and ethics in education*. In International Topkapı Congress III (pp. 38-43).
- Kılıc, A. (2010). Learner-centered micro teaching in teacher education. *International Journal of Instruction*, 3(1), 60-100.
- Kocagül, M. & Ünal Çoban, G. (2024). Evaluation of pre-service science and math teachers' online teaching experiences within the TPACK framework. *Journal of Educational Technology and Online Learning*, 7(2), 149-167. <https://doi.org/10.31681/jetol.1332419>
- Kurt, H., & Ekici, G. (2013). The effect of the educational planning and evaluation lesson on pre-service teachers' self-efficacy beliefs related to the teaching process. *Elementary Education Online*, 12(4), 1157-1172.
- Kurt, H., Ekici, G., & Güngör, F. (2014). The effect of classroom management course on self-efficacy of student teachers regarding teaching. *Procedia-Social and Behavioral Sciences*, 116, 791-795. <https://doi.org/10.1016/j.sbspro.2014.01.299>
- Lau, W. W. F. (2022). Predicting pre-service mathematics teachers' teaching and learning conceptions: the role of mathematical beliefs, mathematics self-efficacy, and mathematics teaching efficacy. *International Journal of Science and Mathematics Education*, 20, 1141-1160. <https://doi.org/10.1007/s10763-021-10204-y>
- Luckin, R., & Holmes, W. (2016) *Intelligence unleashed: an argument for ai in education*. UCL Knowledge Lab: London, UK.
- McMinn, M., & Aldridge, J. (2020). Learning environment and anxiety for learning and teaching mathematics among preservice teachers. *Learning Environments Research*, 23, 331-345. <https://doi.org/10.1007/s10984-019-09304-y>
- Nayiroğlu, B., & Tutak, T. (2024). The role of artificial intelligence in mathematics teaching: analysing the tools used in education. *Turkish Journal of Educational Studies*, 11(1), 65-78. <https://doi.org/10.33907/turkjes.1415591>
- Olson, A., & Stoehr, K. (2019). From numbers to narratives: Preservice teachers' experiences with mathematics anxiety and mathematics teaching anxiety. *School Science and Mathematics*, 119(2), 72-82. <https://doi.org/10.1111/ssm.12320>

- Orak, C., & Turan, Z. (2024). Using artificial intelligence in digital video production: A systematic review study. *Journal of Educational Technology and Online Learning*, 7(3), 286-307. <https://doi.org/10.31681/jetol.1459434>
- Ozben, A., & Kilicoglu, E. (2021). The development process of classroom teacher candidates for teaching mathematics: self-efficacy, anxiety and professional belief. *Participatory Educational Research (PER)*, 8(2), 129-146. <https://doi.org/10.17275/per.21.33.8.2>
- Özdemir, M., & Dođruöz, E. (2020). *Bilimsel Arařtırma Desenleri*. In N. Cemalođlu (Ed.) Bilimsel Arařtırma Teknikler ve Etik. (pp. 65-102). Ankara.
- Özdemir, S. M. (2008). An investigation of prospective primary teachers' self-efficacy beliefs regarding teaching process in terms of certain variables. *Educational Administration: Theory and Practice*, 54, 277-306.
- Özpinar, İ. (2021). Self, peer, group and faculty member assessment: from the perspective of teacher competencies. *Cumhuriyet International Journal of Education*, 10(3), 949-973. <https://doi.org/10.30703/cije.754885>
- Öztürk, S., & Serin, M. K. (2020). Examination of pre-service primary school teachers' metacognitive awareness with anxiety towards mathematics teaching. *Kastamonu Education Journal*, 28(2), 1013-1025. <https://doi.org/10.24106/kefdergi.705074>
- Öztürk, Y., Özer, Z. & Gangal, M. (2022). Investigation of pre-service teachers' planning process of the activity plan. *Journal of Education for Life*, 36(3), 751-774. <https://doi.org/10.33308/26674874.2022363464>
- Patkin, D., & Greenstein, Y. (2020). Mathematics anxiety and mathematics teaching anxiety of in-service and pre-service primary school teachers. *Teacher Development*, 24(4), 502-519. <https://doi.org/10.1080/13664530.2020.1785541>
- Peker, M. (2006). The development of mathematics teaching anxiety scale. *Eđitim Bilimleri ve Uygulama*, 5(9), 73-92.
- Peker, M. (2009a). Pre-service teachers' teaching anxiety about mathematics and their learning styles. *Eurasia Journal of Mathematics, Science and Technology Education*, 5(4), 335-345. <https://doi.org/10.12973/ejmste/75284>
- Peker, M. (2009b). The use of expanded microteaching for reducing pre-service teachers' teaching anxiety about mathematics. *Scientific Research and Essay*, 4(9), 872-880.
- Peker, M., & Ertekin, E. (2011). The relationship between mathematics teaching anxiety and mathematics anxiety. *The New Educational Review*, 23(1), 213-226.
- Pul, H. H., & Aksu, H. H. (2020). Primary school teachers' and prospective teachers' self-sufficiency confidence on teaching maths. *Journal of Education, Theory and Practical Research*, 6(1), 99-114.
- Remesh A. (2013). Microteaching, an efficient technique for learning effective teaching. *Journal of Research in Medical Sciences*, 18(2), 158-163.
- Richardson, F. C., & Suinn, R. M. (1972). The mathematics anxiety rating scale: psychometric data. *Journal of Counseling Psychology*, 19(6), 551-554. <https://doi.org/10.1037/h0033456>
- řahinkaya, N. (2008). *Comparison of class teachers' and preservice teachers' roles in teaching-learning process and self-efficacy beliefs and teacher preparation programs in Turkey and Finland*. (Publication No. 218470) [Doctora Thesis, Gazi University]. CoHE Thesis Center.
- Segarra, J., & Julià, C. (2022). Mathematics teaching efficacy belief and attitude of pre-service teachers and academic achievement. *European Journal of Science and Mathematics Education*, 10(1), 1-14. <https://doi.org/10.30935/scimath/11381>
- Serin, M. K. (2017). Investigation of pre-service primary school teachers' mathematics anxiety and mathematics teaching anxiety. *International Congress of Eurasian Social Sciences (ICOESS)*, 8(28), (CCXXVII- CCXLIII).
- Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2), 4-14.
- Sırmacı, N. & Konyalıođlu, A.C. (2021). Preservice elementary mathematics teachers' self-efficacy beliefs towards instruction process. *Eređli Faculty of Education Journal (NEUEEFD)*, 3(2), 144-155. <https://doi.org/10.51119/ereegf.2022.17>

- Sok, S. (2023, February 15). *Opinion: benefits and risks of chatgpt in education*. Cambodianess.
- Sok, S., & Heng, K. (2023). ChatGPT for education and research: A review of benefits and risks. *Cambodian Journal of Educational Research*, 3(1), 110-121.
- Swars, S., Hart, L. C., Smith, S. Z., Smith, M. E., & Tolar, T. (2007). A longitudinal study of elementary pre-service teachers' mathematics beliefs and content knowledge. *School Science and Mathematics*, 107(8), 325-335. <https://doi.org/10.1111/j.1949-8594.2007.tb17797.x>
- Tapan Broutin, M. S., (2024). Exploring mathematics teacher candidates' instrumentation process of generative artificial intelligence for developing lesson plans. *TÜBA Higher Education Research/Review*, 14(1), 165-176. <https://doi.org/10.53478/yuksekokretim.1347061>
- Tatar, E., Zengin, Y., & Kağızmanlı, T. B. (2015). What is the relationship between technology and mathematics teaching anxiety?. *Journal of Educational Technology & Society*, 18 (1), 67-76.
- Temur, S. (2024). Potential benefits of integrating artificial intelligence into the education system. *Western Anatolia Journal of Educational Sciences*, 15(3), 2621-2656. <https://doi.org/10.51460/baebd.1541524>
- Tertemiz, N., & Şahinkaya, N. (2010). The effects of project and activity-supported instruction on preservice elementary teachers' mathematics teaching efficacy beliefs. *Bolu Abant İzzet Baysal University Journal of Faculty of Education*, 10(1), 87-98.
- Tüzer-Ünsal, G., & Akay, C. (2020). High school students' mathematics achievement, anxiety and attitudes towards instructional technologies: geogebra dynamic software. *Kastamonu Education Journal*, 28(1), 234-252. <http://dx.doi.org/10.24106/kefdergi.3538>
- Unlu, M., Ertekin, E., & Dilmac, B. (2017). Predicting relationships between mathematics anxiety, mathematics teaching anxiety, self-efficacy beliefs towards mathematics and mathematics teaching. *International Journal of Research in Education and Science*, 3(2), 636-645.
- Utley, J., Moseley, C., & Bryant, R. (2010). Relationship between science and mathematics teaching efficacy of preservice elementary teachers. *School Science and Mathematics*, 105(2), 82-87. <https://doi.org/10.1111/j.1949-8594.2005.tb18040.x>
- Yavuz, G., Arslan, Ç., & Batdal Karaduman, G. (2018). The relation between prospective mathematics teachers' inquiry skills and mathematics teaching anxiety. *Turkish Studies Educational Sciences*, 13(11), 1461-1471. <http://dx.doi.org/10.7827/TurkishStudies.13360>
- Yazlık, D. Ö., & Çetin, İ. (2020). Examining the relationship between mathematics anxiety and mathematics teaching anxiety of prospective mathematics teachers. *Turkish Journal of Computer and Mathematics Education*, 11(3), 646-667. <https://doi.org/10.16949/turkbilmat.605951>
- Yerlikaya, G., & Takunyacı, M. (2020). Investigation of self-efficacy perceptions towards mathematics as predictors of mathematics teachers' teaching efficacy beliefs. *Journal of Individual Differences in Education*, 2(1), 42-51.
- Yeşilyurt, E. (2021). Öğretimde plan yapma: Boyutlar, ilkeler, faydalar, hatalar. *INSAC International Congress on Scientific Developments for Social and Education Sciences*, (pp.92-100). Konya, Türkiye.
- Yıldız, H. (2022). Preservice elementary mathematics teachers' evaluations of microteaching practices. *Turkish Journal of Mathematics Education*, 3(3), 1-25.
- Yuskovych-Zhukovska, V., Poplavska, T., Diachenko, O., Mishenina, T., Topolnyk, Y., & Gurevych, R. (2022). Application of artificial intelligence in education. problems and opportunities for sustainable development. *Broad Research in Artificial Intelligence and Neuroscience*, 13(1), 339-356. <https://doi.org/10.18662/brain/13.1Sup1/322>
- Zehir, H., Zehir, K., & Ağgöl-Yalçın, F. (2019). Investigation of pre-school teachers' mathematics teaching competence beliefs according to various variables. *International Journal of Education Science and Technology*, 5(1), 1-14.
- Zengin, Y. (2017). The investigation of the effect of GeoGebra software on mathematics anxiety and mathematics teaching anxiety. *YYU Journal of Education Faculty*, 14(1), 908-939.