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Development of the Inventory of Elementary Mathematics Pre-service Teachers' Study Strategies During Distance Education

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ABSTRACT

Students all over the world who have gone through processes such as pandemics or earthquakes have switched from face-to-face education environments to distance education environments. This has created radical changes for education systems. These changes primarily affect pre-service elementary mathematics teachers enrolled in courses with applications. In these contexts, the aim of this study is to develop an inventory named "Study Strategies of Pre-Service Elementary Mathematics Teachers' During Distance Education" to examine the study strategies of pre-service elementary mathematics teachers. We performed reliability analyses, exploration factor analyses, and confirmatory factor analyses using IBM SPSS 26 and IBM AMOS 24 software. As a result of the analysis, course processes-assignments and projects and preparation for exams subscales were formed, and inventory is finalized.

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1. Introduction

Conditions affecting human life, such as epidemics, natural disasters, and widespread diseases, cause comprehensive changes in education systems. The Corona virus, also known as COVID-19, has impacted the entire world and brought about significant changes. Türkiye, like the rest of the world, completely closed its schools and transitioned to distance education systems. Regardless of time and place, education and training activities persisted at all levels of education. To put it another way, global and local events in Türkiye primarily impact university students. The Ministry of National Education (MoNE) conducted online platforms and distance education courses at primary and secondary education levels during the COVID-19 process in March 2020 but did not hold students' semester exams on these platforms. However, university students continued to complete all their courses and take their semester exams through distance education platforms. Especially in the faculties of education that train teachers, in addition to the theoretical courses, practical courses, such as teaching practice, in which pre-service teachers gain experience, have continued to be carried out in the form of distance education. In addition to the pandemic, Turkey also experienced a similar distance education experience in the earthquake that occurred in February 2023. During this process, the online implementation of all courses, including teaching practices, may have caused changes in the working habits of pre-service elementary mathematics teachers due to practical courses conducted 'on screen.'

Since the pandemic, distance education has become even more important (Durak, Çankaya, and İzmirli, 2020). Rashid and Yaday (2020) stated that the continuation of educational services and communication on more digital platforms may become a norm after the pandemic. This is a situation that increases the importance of distance education studies. Furthermore, the pandemic has impacted the social lives, work, and academic pursuits of distance education students, necessitating their transformation

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(Aristeidou and Cross, 2021). Processes such as COVID-19 and earthquakes have indeed increased the need for distance education. Continuous use of distance education has become the norm. Given these circumstances, it is crucial to understand the nature of students' study strategies in distance education. Studies on this subject will provide information about the situations that educational institutions should pay attention to in their applications.

One of the most important tasks of educators is to ensure that students benefit from educational activities at the maximum level and to bring their study strategies to a more effective and efficient level (Tezer, Gülyaz Cumhur and İldırımlı, 2020). Magulod Jr. (2019) stated that by developing excellent study habits for mathematics learners, it will be possible to raise students who learn better and have high academic achievement. The elementary mathematics teaching program differs from other programs in the faculty of education due to the numerical content of its courses, which encompass both mathematics and educational fields. Balancing this dual structure in distance education is challenging; therefore, study strategies need to be examined in a comprehensive manner. For this reason, it is crucial to understand the study strategies employed by pre-service elementary mathematics teachers during the pandemic period. Pre-service mathematics teachers are individuals who have the potential to become teachers and pass on their experiences to future generations. Researchers believe that understanding the strategies pre-service mathematics teachers employ when switching from in-person instruction to remote learning platforms can enhance their effectiveness. The individual experiences they gain will help them guide their students in their professional lives in the future. At this point, the Ministry of National Education's 2023 Education Vision (MoNE, 2019) emphasise the development of mathematical literacy as a strategic goal. This goal highlights the importance of training pre-service mathematics teachers with strong work strategies. Higher Education Council data (2023) shows that there is a continuing shortage of mathematics teachers in Turkey. Therefore, integrating the work strategies acquired during the distance education process into teacher training programmes will both facilitate the adaptation of pre-service teachers to the profession and contribute to the country's efforts to meet its teacher needs. For these reasons, a systematic examination of the strategies specific to distance education among these pre-service elementary mathematics teachers will enhance the quality of teacher training programmes and provide guidance for field applications. In these contexts, the aim of the study is to develop the inventory of "Study Strategies of Pre-Service Elementary Mathematics Teachers' During Distance Education".

1.1. Conceptual Frameworks

We analysed the concepts of students' learning and learning styles during the inventory construction process to identify study strategies and the factors influencing these strategies. While ''style'' describes relatively stable personal preferences for cognitive processing or learning, ''strategies'' and ''approaches'' are more contextually specific and influenced by the context and environment (Entwistle and Peterson, 2004). The COVID-19 pandemic's changes in the environment and content prompted the development of this inventory and the use of study strategies.

The basic condition for the establishment of education is learning (Güneş and Bedir, 2022). Educators recognize the critical importance of understanding individual learning styles and emphasize the importance of conscious attempts to integrate these learning styles into educational programs (Cassidy, 2004). When considering students, some students learn through theories and mathematical models; others use visual information such as pictures, diagrams, and simulations for better understanding; while others may learn better from oral and written information (Çakıroğlu, 2014). According to Berková et al. (2020), students' preferences in the learning process—the way they acquire curriculum and process information—are an important factor for quality pedagogical activities. Boydak (2015) defined learning style as "the characteristic that makes us who we are." These definitions suggest that there is no one way to learn, and everyone possesses a unique learning style.

Students study to learn (Gökcen, 2022). Learning is a process, and certain interactions may lead to changes in learning. When we acknowledge that learning persists throughout life and undergoes changes, we also acknowledge that students can cultivate diverse learning styles based on their

circumstances. While it is important to examine how students learn in different situations, it is equally important to understand how they study to enhance their learning. Hussman and O'Loughling (2019) defined out-of-school study time as a time when students can incorporate their perceived learning style or preference through specific study strategies, independent of instructors or administrations. In other words, students choose a study strategy based on their preferred learning style. By addressing students' learning styles and planning instruction accordingly, educators will meet the educational needs of more individuals and be more successful in their educational goals (Watson and Thompson, 2001). There are different models reflecting learning styles in the literature. We summarise the learning style models used in this study below.

Table 1. Summary of Learning Style Models

Dunn and Dunn Learning Styles Model	The topics affecting student success are environmental factors, emotional factors, sociological factors, physiological factors and psychological factors (Dunn and Burke, 2006).
Kolb's Experiential Learning Styles Model	He stated that learning is in the form of a cycle. There are 4 learning styles in the cycle: Discriminators, Assimilators, Convergers and Accommodators (Sudria, Redhana, Kirna, and Aini, 2018).
Felder and Silverman Learning Model	Five categories are appropriate and inclusive for this model explaining engineering education learning: Perceptual-Intuitive, Visual-Linguistic, Active-Reflective, Sequential-Integral Learning Styles (Felder and Henriques, 1995).
Gregorc Learning Styles Model	Gregorc summarised four different thinking style patterns: (a) concrete sequential, (b) concrete random, (c) abstract sequential and (d) abstract random. (Watson and Thompson, 2001).

1.2. Related Scales, Surveys, And Inventory Development Research

Gül (2011) aimed to reveal the relationship between students' learning styles and their learning and study strategies. Gül (2011) examined the relationships between the time score subscale of the Learning Styles Scale and the anxiety, attitude, and test score subscale of the Learning and Study Strategies scales, determining significant positive relationships. Yılmaz (2013) compared the learning and study strategies of 4th and 5th grade students studying in teachers' classes with different attitudes. In the study in which the inventory for determining study strategies was used, the results were examined; differentiation occurred between students in strategies such as making sense, organizing, and monitoring comprehension (Yılmaz, 2013).

Being conscious about the learning process and using effective study strategies will significantly increase students' success in school (Yıldırım, Doğanay, and Türkoğlu, 2009). However, students are unaware of the best study strategies (Morehead, Rhodes and DeLozier, 2016). This situation may affect students' learning and academic achievement. Effective study strategies and methods learned by the student during the study process lead to success (Etin, 2018). In the literature, studies examining the relationship between studying and academic achievement were found (Aquino, 2011; Bahar and Okur, 2018; Capuno et al., 2019; Durukan, Batman and Yiğit, 2015; Gentry, 2012; Magulod Jr., 2019; Siahi and Maiyo, 2015; Neroni et al., 2019; Tezer, Gülyaz Cumhur and İldırımlı, 2020; Özonur and Kamişli, 2019; Walk Shannon, Rowell and Frey, 2021). Capuno et al. (2019), in their study with 9th grade students in the Philippines, stated that students' attitudes and study habits are important factors affecting their performance in mathematics. Magulod Jr. (2019) conducted a study in the Philippines that analyzed the learning style preferences, study habits, and academic achievement levels of students enrolled in applied science courses at a public higher education institution. The study revealed significant relationships between students' study habits and academic performance. In another study examining the relationship between academic achievement and students' study habits, Cerna and Pavliushchenko (2015) found it important to determine the habits of high-performing students. Therefore, their aim was to identify the study habits of high-achieving students as a means of enhancing their poor performance.

It has been revealed by various studies that the study program affects study habits (Tümkaya and Bal, 2006; Durukan, Batman, and Yiğit, 2015; Çetin, 2018). This study aims to create an inventory, based on the courses in the Primary Mathematics Teacher Education curriculum, to identify new study strategies that pre-service teachers may encounter in a different classroom environment. Furthermore, study habits encompass a diverse range of behaviors, ranging from the duration of students' study sessions,

the strategies they employ during their studies, and the environment in which they study (Walck-Shannon, Rowell, and Frey, 2021). Other factors affecting study habits have also been examined in the literature (Erdamar, 2010; Mendezebal, 2013; Yiğit, 2014; Siahi and Maiyo, 2015; Çetin, 2018; Peker Ünal, 2021). Siahi and Maiyo (2015) stated that good health, adequate sleep, proper exercise, and a nutritious diet are necessary to achieve good study results; they also stated that inadequate lighting, extreme temperatures, humidity, poor posture, subnormal physical conditions, and emotional discomfort are among the unfavourable study conditions.

To determine the preferred study methods of students, Anderson, Ogruk, and Bell (2021) found that the most preferred method for those preparing for certification exams was teacher-led study. Self-study and studying with books are the least preferred methods. We also observed that most of the successful participants preferred to study alone at home for 2-4 hours a day. Other successful students began their studies 1-2 weeks prior to the exam. Unsuccessful students thought that the presence of panic or anxiety affected the exam result negatively.

COVID-19 moved education and training activities to distance education platforms in 2019, and the learning-teaching processes continued. The literature asserts that distance learners experience significantly different learning conditions, which in turn significantly influence their learning outcomes (Landbeck and Mugler, 2000). Learners do not work in isolation, even at a distance, and there are many factors that will influence their experiences and therefore their learning opportunities and their role as learning leaders (Cox and Quinn, 2021). By addressing students' learning styles and planning instruction accordingly, educators will meet the educational needs of more individuals and be more successful in their own educational goals (Watson and Thompson, 2001). The International Association of Universities (IAU) initiated the IAU Global Survey to better understand the negative impacts of COVID-19 on higher education and to investigate the measures taken by higher education institutions worldwide to respond to the crisis (Marinoni, Van't Land, and Jensen, 2020). Many faculty members and students around the world also participated in the survey. The survey results indicated that the COVID-19 period presented an opportunity for learning and teaching, potentially leading to changes in mindsets (Marinoni, Van't Land, and Jensen, 2020). Recognizing the potential impact of the COVID-19 pandemic on distance education students, Aristeidou and Cross (2021) investigated how a break from face-to-face education affected students' study habits. Students participating in the study reported limited interaction and difficulties managing their workload. A virtual classroom limits friendship and a sense of belonging (Rashid and Yadav, 2020). This had a negative impact on students' study habits. Although there are numerous studies in the literature examining students' study strategies, there is no measurement tool specific to pre-service elementary mathematics teachers and in the context of distance education. The increase in distance education practices after the pandemic clearly shows that study strategies should not be limited to findings reported in face-to-face settings. Studies questioning the effects of distance education on learning outcomes (Marinoni, Van't Land, and Jensen, 2020; Cox and Quinn, 2021) have drawn attention to the difficulties students experience in terms of lack of interaction, workload management, and sense of belonging. These findings further highlight the need to quantitatively map the unique study strategies developed by pre-service teachers in online environments. This study aims to fill this gap by developing the first inventory that measures the study strategies of pre-service elementary mathematics teachers in a distance education context. The inventory items were developed by considering both mathematics content knowledge and distance learning experiences and were designed to be consistent with learning style sub-dimensions. This will provide detailed data for instructional designers and researchers.

2. Method

2.1. Research Design

We developed the inventory, "Study strategies of pre-service elementary mathematics teachers during distance education". The literature suggests that we should not refer to measurement tools with multiple dimensions and inability to obtain a total score as tests or scales, but rather as inventory (Erkuş, 2010).

Furthermore, Aiken (1997) asserted that while we use names like inventory, questionnaire, and scale, the name itself holds no significance. We finalised the development and usability of the inventory by conducting the necessary factor analyses for each subscale. This section outlines the stages involved in creating the inventory.

2.2. Inventory Development Steps

Firstly, we conducted a literature review to create the inventory. We also reviewed existing scales, questionnaires, and inventories. These analyses led to the drafting of inventory sections and items. While creating the inventory items, the social media and Science Learning Survey developed by Moll and Nielsen in 2017 was utilised for the statements in the subscales of assignments and projects covering students' course study processes. Since some of the applications used for learning in this inventory are among the resources that can also be used while studying, the subscale of the sources used by pre-service elementary mathematics teachers in the courses was adapted. The Elementary Mathematics Teacher Education Programme adapted and used the statements from the ''Social Media and Science Learning Inventory'' to complete assignments in its mathematics courses. The Elementary Mathematics Education Teacher Training Program has two different course types: mathematics courses and educational courses. Current study includes mathematics courses. For mathematics courses, courses such as analysis, linear algebra, analytical geometry, differential equations, statistics and probability, algebra, and elementary number theory were taken as the basis. We used expert opinion from 3 English language teachers to translate the items from the Moll and Nielsen (2017) inventory into Turkish. We also sought the opinions of 2 Turkish teachers regarding the language structure of the adapted sentences. The absence of negative sentence structure in the inventory items eliminated the need for reverse coding.

Secondly, we obtained expert opinions from field experts to ensure content validity. We contacted three faculty members who are experts in mathematics education and one faculty member who is an expert in measurement and evaluation to obtain expert opinions. All experts agreed to examine the inventory. We sent the Expert Opinion Form to the experts via e-mail, asking them to comment on the compatibility of each inventory item. We also asked them to suggest items for addition or removal. The experts' feedback led to the finalisation of the inventory items. The finalized inventory consists of two sections:

(A) Demographic Information: In the first part, to determine the demographic characteristics of the sample to be applied, multiple-choice questions were asked about gender, grade level, weighted GPA, and the type of enrolment in the program, and the pre-service teachers were asked to mark the appropriate option.

(B) Sources used by pre-service teachers: We asked students to identify the resources they used while studying in this section. These resources include internet resources, library resources, and lecture notes. Students have the option to add additional sources not included in this list. The data in this section is suitable for descriptive analysis.

(C) Distance Education: The second part of the inventory asked pre-service teachers to describe the processes they experienced during the distance education process. We divided the statements about distance education into two subscales: (a) course processes, including assignments and projects, and (b) exam preparation. We asked pre-service teachers to categorize their resource usage frequency as ''(1) I don't use, (2) I use infrequently, or (3) I use frequently''.

The statements in the subscales of (a) the course process—assignments and projects—and (b) preparation for exams were organized in line with the courses taken by pre-service elementary mathematics teachers. Pre-service teachers' mathematics courses were the basis for these subscales. For Mathematics Courses, courses such as Analysis, Linear Algebra, Analytical Geometry, Differential Equations, Statistics and Probability, Algebra, and Elementary Number Theory were taken as basis. A five-point Likert scale was used in the statements in the (a) Course Processes – Assignments and Projects and (b) Preparation for Exams subscales of the inventory. The purpose of using the Likert scale is to

determine the average attitudes of people toward the items based on the combined values of all the questions (Turan, Şimşek, and Aslan, 2015).

We asked pre-service teachers to check the frequency of their participation in the statements "(1) Never, (2) Rarely, (3) Sometimes, (4) Frequently, (5) Always". We added a multiple-choice question to gather more detailed information during the exam preparation. There are 23 statements in total in the subscales of (a) the course process – assignments and projects and (b) preparation for exams. We added two multiple-choice questions to the inventory to gather detailed information about the pre-service teachers' exam preparation. Additionally, the multiple-choice questions exhibit descriptive features. The current study will not discuss the descriptive components of the inventory.

2.3. Sample

The sample of the developed inventory consisted of a total of 195 2nd, 3rd, and 4th grade pre-service teachers enrolled in the Primary Mathematics Teacher Education program at the Faculty of Education of three state universities in Türkiye. We used online communication during the pandemic period to carry out the data collection process. Due to this limitation, the return rates received from pre-service teachers were low during the pandemic period. We preferred universities that were reachable during the pandemic period for sample selection, given the possibility of online communication. We preferred convenience sampling when selecting universities. Convenience sampling is a type of sampling based on convenience (Patton, 2014). We used purposive sampling to select pre-service teachers, considering the characteristics required by the research. The selection of pre-service teachers at the 2nd, 3rd, and 4th grade levels was based on their experience in both face-to-face and distance education periods during their university education. We excluded 1st grade pre-service teachers from the sample due to their new experiences at the university. In addition to continuing online education during COVID-19, the pre-service teachers in the selected sample also participated in online exams. This allows us to collect data on their exam preparation processes.

The table below shows the distribution of the research sample by gender, grade level, weighted grade point average (GPA), and type of program enrolment.

Table 2. Demographic Information Frequency Distribution

		f	%
What is your gender?	Female	153	78.5
	Male	42	21.5
	Total	195	100.0
What is your grade level?	2nd grade	60	30.8
	3rd grade	79	40.5
	4th grade	56	28.7
	Total	195	100.0
What is your GPA?	2.01-2.50	4	2.1
	2.51-3.00	25	12.8
	3.01 and above	166	85.1
	Total	195	100.0
What is your type of Enrolment to programme?	Central Exam	158	81.0
	Transfer	29	13.9
	Foreign Student	8	4.1
	Total	195	100.0

2.4. Data Analysis

We performed exploratory factor analysis (EFA) and reliability tests using IBM Statistical Package for the Social Sciences (SPSS) Version 26 to obtain the validity and reliability results of the inventory. We used IBM SPSS AMOS Version 24 for confirmatory factor analyses. Prooijen and Kloot (2001) assessed the extent to which results from exploratory factor analysis (EFA) studies may be replicated using confirmatory factor analysis (CFA) within the same sample. The authors contend that if the adequacy of fit is ambiguous when the factor structure is assessed confirmatively on the same dataset, one cannot

expect that a confirmative follow-up study using a different dataset will produce a good fit. In conclusion, they claimed that the same data set is utilised to develop a factor model by EFA and then assess this model using CFA.

3. Results

This section will present the results of the factor analyses conducted during the development of the inventory. We performed first exploratory factor analysis and then confirmatory factor analysis for each of the subscales in the inventory to ensure construct validity. We then explained the validity and reliability tests below.

3.1. Exploratory Factor Analysis (EFA) Results

Kaiser-Meyer-Olkin (KMO) value and Barlett test ($p<0.5$) were applied to the data, and their suitability for factor analysis was examined. As a result of the analysis, the KMO sampling adequacy index was found to be .740 for the course processes – assignments and projects subscale and .743 for the preparation for exams subscale. The sample is adequate if the KMO value is more than 0.7 (Rasheed and Abadi, 2014). The reason for calculating 2 different KMO values is that the 2 subscales contain different items and reflect different scopes. In addition, Bartlett's significance index was found as P =.000 ($p<.05$). Therefore, the data were suitable for exploratory factor analysis (Dziuban and Shirkey, 1974).

There are two types of rotation methods in the SPSS program. These are oblique (Promax, direct oblimin) and orthogonal rotation (varimax, quartimax, equimax) methods. Among these rotation methods, orthogonal rotation methods do not allow the factors found to be correlated, whereas oblique rotation methods allow the factors obtained to be correlated (Costello and Osborne, 2005). For this reason, oblique rotation methods were preferred in this study. The Promax Rotation method was used to obtain more realistic results and to avoid negative factor loadings for all 23 items in the course processes – assignments and projects and preparation for exams subscales. Studies aiming to obtain descriptive data may encounter an item overlapping with more than one factor (Tabachnick and Fidell, 2007). To avoid this situation, factor loadings below .30 were ignored in this study. Factor loadings of .30 and above are commonly used (Spector, 1992).

Table 3. Course Processes – Assignments and Projects subscale EFA Identified Factors

Factors	Items	Factor Load	Eigenvalue	Variance	Cumulative Variance
	M1.	.836	3.583	32.571	32.571
	M2.	.863			
	M6.	.727			
	M7.	.780			
	M3	.807	1.876	17.056	49.627
	M4	.916			
	M5	.876			
	M8	.548	1.556	14.144	63.771
	M9	.901			
	M10	.863			
	M11	.407			

In Table 3, the factors determined for the course processes – assignments and projects subscale and the items belonging to these factors are listed, and their factor loads are given. As a result of the exploratory factor analyses, 3 factors with a total of 63.771% explanatory variance were obtained in the course processes – assignments and projects subscale. The explained variance exceeding 50% is an important criterion for factor analysis (Yaşlıoğlu, 2017).

Three factors yielded a total explanatory power of 54.036% in the subscale of exam preparation. Table 4 lists the factors determined for the exam preparation subscale, the items belonging to these factors, and their factor loadings.

Table 4. Statistical results

Factors	Items	Factor Load	Eigenvalue	Variance	Cumulative Variance
	M3	.661	3.459	28.822	28.822
	M4	.852			
	M5	.639			
	M10	.789			
	M7	.573	1.872	15.602	44.425
	M8	.544			
	M12	.783			
	M13	.918			
	M2	.414	1.153	9.612	54.036
	M6	.864			
	M11	.577			
	M14	.734			

3.2. Confirmatory Factor Analysis (CFA) Results

We conducted confirmatory factor analysis on the subscales of the inventory to confirm the factors obtained using exploratory factor analysis.

Table 5. Course Processes – Assignments and Projects CFA Results

DFA	CMIN/DF (x2/sd)	GFI	AGFI	SRMR	NFI	CFI	RMSEA
Course Processes – Assignments and Projects Items	1.730	.933	.897	.0762	.904	.957	.061

When the confirmatory factor analysis results for the course processes – assignments and projects subscale were analysed, it was seen that the CMIN/DF (x2/sd) ratio was lower than 3. CMIN/DF (x2/sd) ratio less than 3 is an acceptable value (Kleine, 2015). The literature (Uzun, Gelbal, and Retmen, 2010) states that Goodness of Fit Index (GFI) and Adjusted Goodness of Fit Index (AGFI) values greater than 0.80 are acceptable. Normed Fit Index (NFI) indices greater than .80 (Forza and Filippini, 1998) and Comparative Fit Index (CFI) indices greater than .90 (Uzun, Gelbal, and Öğretmen, 2010), Standardised Root Mean Square Residual (SRMR) (Hu and Bentler, 1999), and Root Mean Square Error of Approximation (RMSEA) fit indices less than 0.80 (Browne and Cudeck, 1992) are considered acceptable in the literature.

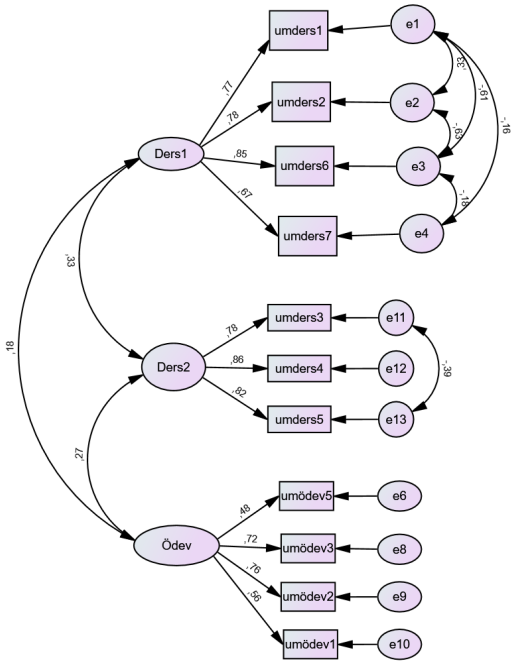

Figure 1. Course Processes – Assignments and Projects Subscale Factor Structure

Figure 1 shows the graph of the 3-factor structure obtained during the course processes - assignments and projects. Confirmatory factor analysis for the subscale of preparation for exams is given in the table below.

Table 6. Preparation For Exams CFA Results

DFA	CMIN/DF (x2/sd)	GFI	AGFI	SRMR	NFI	CFI	RMSEA
Preparation for Exams Items	1,807	.921	.889	.0657	.826	.912	.065

Analysis of the confirmatory factor analysis results for the exam preparation subscale revealed that the CMIN/DF (x2/sd) ratio was less than 3. GFI and AGFI values are greater than 0.80. NFI value is greater and .80, and CFI value is greater than .90. Table 6 reveals that the RMSEA and SRMR fit indices fall below 0.80. Figure 2 presents the graph of the factorial structure that surfaced in the exam preparation subscale.

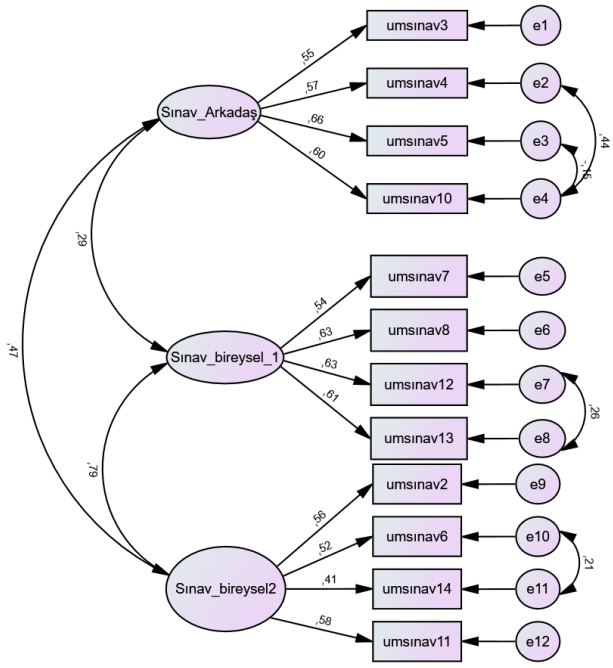

Figure 2. Assignments and Projects Subscale Factor Structure

3.1. Reliability Analysis

In this study, the Cronbach Alpha (a) internal consistency coefficient was examined for the reliability analysis phase. Analyses of the subscales of the inventory revealed information about their validity and reliability.

Firstly, two items were removed from the course processes - assignments and projects subscale of the inventory for the suitability of the factor analyses of the reliability analysis. The exam preparation subscale had three items removed from it. These items had an impact on reliability and were found to have low factor loadings among the factors in factor analyses. Simultaneously, we deemed it appropriate to remove items with similar scope.

Table 7. Reliability Analysis Results of İnventory Subscales

Reliability Analysis	Cronbach's Alpha	Number of Items	Mean	Variance
Course Processes – Assignments and Projects Items	.787	11	36.3026	37.686
Preparation For Exams Items	.766	12	38.0718	45.943

Cronbach Alpha (a) was calculated as 0.787 for the items in the course process – assignments and projects subscale. The Cronbach Alpha (a) for exam preparation is 0.766. These values indicate that the

internal consistency is high. We calculated the item-total correlation for the item statistics in the inventory. We can analyse the relationship between each item in the subscales and the total item score in the table below.

Table 8. Statistics of Course Process – Assignments and Projects Subscale Items

Items	Mean	Standard Deviation	Item Total Correlation	Cronbach Alpha if item is deleted
M1	3.2000	1.11503	.528	.760
M2	3.3385	1.10682	.547	.758
M3	2.6154	.94747	.453	.769
M4	3.0564	.92050	.557	.759
M5	3.1897	.99995	.465	.768
M6	2.6513	1.00074	.486	.766
M7	3.0462	1.27745	.479	.768
M8	3.9897	.90240	.462	.769
M9	4.1282	.69533	.261	.787
M10	4.1538	.73001	.259	.787
M12	2.9333	1.02075	.333	.783

Reviewing the table reveals that the item-total score correlations exceed 0.30. Büyüköztürk (2021) stated that items with an item-total correlation of 0.30 and higher have good discrimination power. For M9 and M10 items, Büyüköztürk (2021) stated that factor loadings between .20 and .30 can be included when necessary. Removing these items leads to a decrease in the inventory's content. In addition, there is no overarching question in the inventory for this item, so when the item is removed, it reduces the scope of the inventory. Therefore, these items were not removed. In addition, there were no items with negative item-total score correlations. Examining the values in the last column reveals the impact of item deletion on Cronbach Alpha. Since the deletion of the items resulted in a decrease in the Cronbach Alpha value, we decided not to delete any items.

Table 9. Statistics of Preparation for Exams Subscale Items

Items	Mean	Standard Deviation	Item Total Correlation	Cronbach Alpha if item is deleted
M2	4.0872	.76495	.320	.758
M3	2.7692	1.18977	.319	.760
M4	2.4462	1.20605	.431	.746
M5	3.4154	1.00861	.374	.753
M6	3.8769	.89398	.379	.752
M7	3.0205	1.30802	.416	.749
M8	3.7846	1.09581	.498	.738
M10	2.0513	1.07810	.364	.754
M11	3.9282	.85251	.523	.740
M12	3.3231	1.07609	.462	.743
M13	2.1692	1.05863	.365	.754
M14	3.2000	1.16034	.415	.748

When the table is examined, it is seen that the item-total score correlations of preparation for exams are above 0.30. There were no items with negative item-total score correlations in the assignments and projects subscale. Analysing the values in the last column reveals the impact of item deletion on Cronbach Alpha. Deletion of items did not affect the Cronbach Alpha value.

4. Discussion and Conclusion

In this study, we developed a valid and reliable "Study Strategies of Pre-Service Elementary Mathematics Teachers During Distance Education" inventory to determine the study strategies of pre-service elementary mathematics teachers during distance education. In this section, a summary of the results obtained will be given and related discussions will be carried out. We suggest subjecting the study resources used by pre-service teachers in the first section of the three-section inventory to descriptive analysis. Similarly, we recommend using descriptive statistics for both open-ended and

multiple-choice questions. Factor analyses, validity, and reliability analyses were conducted for the subscales (a) course processes - assignments and projects (b) preparation for exams. We conducted a validity and reliability study of the inventory with 2nd, 3rd, and 4th grade pre-service teachers from three different state universities in Istanbul. We sought expert opinions during the inventory creation process to ensure both content and face validity. We applied exploratory and confirmatory factor analyses to ensure construct validity.

Unlike this study, the literature includes survey, scale, and inventory development studies that do not pertain to the distance education period (Melancon, 2002; Stroud, 2006; Magno, 2011; Brown et al., 2015; Pawlak, 2018). Therefore, this study adds to the existing literature by specifically focusing on the distance education period. The literature also contains development studies covering the distance education period (Zerbini and Abbad, 2008; Seaman, 2009; Amigud, 2013; Zalli, Nordin and Hashim, 2019; Avila and Genio, 2020), but we believe that the inventory we developed with inclusive items will be useful. Many assessment tools for distance education have been developed for the general student population or teachers, but there are only a limited number of tools that focus specifically on the study strategies of pre-service teachers (and more specifically, pre-service elementary mathematics teachers). For example, although the views of pre-service teachers on distance education were collected in Turkey during the pandemic (Düzgün and Sulak, 2020), these studies were generally limited to measuring general attitudes and experiences using existing measurement tools. There is no measurement tool specific to the study strategies of pre-service elementary mathematics teachers. This situation highlights the original contribution of the present study.

Although measurement tools of online self-regulation and learning strategies have been developed in the international literature since the early 2000s (Barnard et al. 2009, Tsai 2007), measures specific to the sudden and mandatory distance education conditions brought about by the COVID-19 process have only become important in recent years. Kocdar et al. (2018) have even highlighted the need for scales specific to distance learning environments before pandemic. As a result, although there are some measurements in the literature on pre-service teachers' study strategies during distance education, there is a noticeable lack of measurement tools that focus on a specific target group, such as pre-service elementary mathematics teachers, and examine study strategies in detail. Existing studies have primarily focused on general attitudes, self-efficacy, or strategies applicable to all students. This inventory, developed to fill this gap, will contribute significantly to the literature by measuring the study strategies used by pre-service teachers in distance education in terms of dimensions specific to mathematics education. We anticipate that the inventory will facilitate applications, spesific to the elementary mathematics teaching program's courses. The applications will reveal the study strategies pre-service teachers use during courses, in assignments and projects, and in preparation for exams. Thus, pre-service teachers will master the scope of study strategies within the framework of the application results and will contribute to their future professional lives. In addition, the application results will also include information and different strategies for instructors using distance education platforms. In addition, since it will provide detailed information about the course study processes of the students enrolled in the elementary mathematics teaching program, it is thought that it will help the faculty members get to know their students.

To provide more detailed information about the results of the data obtained from the inventory applications, qualitative and quantitative studies can be conducted with the students about the course processes in distance education and also face-to-face education periods. The study is limited to students enrolled in the elementary mathematics teaching program and its associated courses. Therefore, conducting studies across various disciplines can yield diverse results.

Note

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Appendix

UZAKTAN EĞİTİM SÜRECİNDE İLKÖĞRETİM MATEMATİK ÖĞRETMEN ADAYLARININ DERS ÇALIŞMA STRATEJİLERİ ENVANTERİ

A. BÖLÜMÜ: DEMOGRAFİK BİLGİLER

Bu bölümde, hakkınızda çalışmaya yönelik bazı bilgileri öğrenmek amaçlanmıştır.

1.	Cinsiyetiniz nedir?	☐ Erkek ☐ Kadın
2.	Sınıf düzeyiniz nedir?	☐ 2 sınıf ☐ 3. Sınıf ☐ 4. Sınıf
3.	Ağırlıklı Genel Not Ortalamanız (AGNO) nedir?	☐ 2.00 ve altı. ☐ 2.01-2.50 ☐ 2.51-3.00 ☐ 3.01 ve üzeri
4.	Bölüme kayıt türünüz nedir?	☐ ÖSYM ☐ Yatay Geçiş ☐ Dikey Geçiş ☐ YÖS

B. UZAKTAN EĞİTİM SÜRECİ

Bu bölümde, uzaktan eğitim ders süreçlerindeki deneyimlerinizi düşünerek cevap veriniz.

B.1. Ders Çalışmaya Yönelik Kaynaklar

Uzaktan eğitim döneminde aşağıda verilen ders çalışma kaynaklarını kullanım sıklıklarınızı belirtiniz.
Verilen kaynaklar dışında kullandığınız bir kaynak var ise belirtip, kullanım sıklığını bildiriniz.

	KAYNAKLAR	Kullanmam	Seyrek Kullanırım	Sık Kullanırım
1.	Kütüphane kaynakları (kitaplar, basılı yayınlar, e-kitaplar, DVD-VCD vb.)			
2.	Öğretim Elemanları tarafından önerilen ders kitapları			
3.	Video içerikleri (YouTube, Khan Academy, Webinar, TED.com, vb.)			
4.	Arama motorları (Google, yandex,vb), akademik arama (Google akademik)			
5.	YÖK Açık Ders Havuzu			
6.	Tartışma Forumları (ör. Yahoo cevapları, ask.com, Soru-cevap forumları vb.)			
7.	Wiki'ler (ör. Wikipedia, Wikispace'ler vb.)			
8.	Mobil Uygulamalar (Ör: Camscanner, Office Lens, Notes, Evernote, vb.)			
9.	Sosyal haber siteleri (Ör: Pinterest, Reddit vb.)			
10.	Diğer? Lütfen uygulamayı belirtiniz: …….			

B.2. Ders Süreci – Ödevler ve Projeler

Bu bölümde, uzaktan eğitim döneminde ders sürecinde aşağıda verilen durumlara ne kadar katıldığınızı bildiriniz.
Aşağıda verilen soruları Matematik alan derslerini (Analiz, Lineer Cebir, Soyut Matematik vb.) düşünerek cevaplayınız.

		Hiçbir zaman	Nadiren	Bazen	Sık Sık	Her zaman
1.	Matematik derslerinde çevrimiçi ortamda öğretim elemanının sözlü anlatımlarını not alırım.					
2.	Matematik derslerinde çevrimiçi ortamda öğretim elemanının ekrandaki paylaşımlarını not alırım.					
3.	Çevrimiçi matematik derslerinde anlamadığım konuyu o an öğretim elemanına sorarım.					
4.	Matematik derslerinde yazılı (chat, mesaj vb. kısmında) ya da sözlü katılım gösteririm (yorum yapmak, görüş belirtmek, sorulara cevap verme).					
5.	Matematik derslerinde yapılan etkinliklere aktif katılım gösteririm.					
6.	Matematik dersleri başlamadan bir önceki dersi gözden geçiririm veya ders bitiminde dersi tekrar ederim.					
7.	Matematik derslerinde aldığım notları temize geçerim					
8.	Matematik dersleri ödevlerimi tamamlarken takıldığım bir konu olduğunda arkadaşlarımla bilgi alışverişinde bulunurum.					

9.	Matematik dersleri ödevlerimi tamamlarken İnternet ve/veya Google arama motorundan yararlanırım.					
10.	Matematik dersleri ödevlerime yardımcı olacak kaynakları (bağlantılar, videolar, web siteleri) internette aktif olarak araştırırım.					
11.*	Matematik dersleri grup ödevleri ve projeler üzerinde arkadaşlarımla çalışmak amacıyla Google Drive, Edmodo veya Moodle gibi ortak çalışmaya dayalı eğitim araçları kullanırım.					
12.	Ödev ve projeleri yaparken anlamadığım yer olduğunda ders öğretim elemanı ile e-posta aracılığıyla iletişime geçerim.					

*11. madde analizler sonucu envanterden çıkarılmıştır.

B.3. Sınavlara Hazırlık

Bu bölümde, uzaktan eğitim döneminde sınavlara hazırlanırken aşağıda verilen durumlara ne kadar katıldığınızı bildiriniz.

Aşağıda verilen soruları Matematik alan derslerini (Analiz, Lineer Cebir, Soyut Matematik vb.) düşünerek cevaplayınız.

		Hiçbir zaman	Nadiren	Bazen	Sık Sık	Her zaman
1.*	Matematik dersleri sınavlarına hazırlanırken takıldığım bir konu olduğunda arkadaşlarıma çevrimiçi sohbet ortamında sorarım.					
2.	Matematik dersleri sınavlarına hazırlanırken İnternet ve/veya Google'da arama motorundan yararlanırım.					
3.	Matematik dersleri sınavlarına çalışmak amacıyla Google Drive, Edmodo veya Moodle gibi ortak çalışmaya dayalı eğitim araçları kullanırım.					
4.	Matematik dersleri sınavlarına hazırlanırken çevrimiçi veya görüntülü görüşme gibi ortamlarda arkadaşlarıma konu anlatırım.					
5.	Matematik derslerini öğrenmek için elde ettiğim çevrimiçi kaynakları (bağlantılar, belgeler) sınıf arkadaşlarımla paylaşırım.					
6.	Matematik dersleri sınavlarına hazırlanırken üniversitenin uzaktan eğitim ders kayıtlarını sınav öncesinde izlerim.					
7.	Matematik dersleri sınavlarına hazırlanırken bir ders çalışma programı hazırlıyorum.					
8.	Matematik dersleri sınavlarına hazırlanırken özet ders notları çıkararak çalışıyorum.					
9.*	Matematik dersleri sınavlarına hazırlanırken başkalarının hazırladığı özet notlar üzerinden çalışıyorum.					
10.	Matematik dersleri sınavlarına hazırlanırken çevrimiçi veya görüntülü görüşme gibi ortamlarda arkadaşlarım bana konu anlatır.					
11.	Matematik dersleri sınavlarına hazırlanırken öğretim elemanının derste çözdüğü soruları tekrar çözerim.					
12.	Matematik dersleri sınavlarına hazırlanırken derste çözülen sorular dışında örnek soru çözerim.					
13.	Matematik dersleri sınavlarına hazırlanırken kendi kendime sınav yaparım.					
14.	Matematik dersleri sınavlarına hazırlanırken ders notlarının altını çizerek çalışırım.					

*1. ve 9. maddeler analizler sonucu envanterden çıkarılmıştır.

Uzaktan eğitim döneminde bölüm dersleri için sınavlara hazırlanırken ne zaman ders çalışmaya başlıyorsunuz?

a. Sınavlardan bir gece önce
b. Sınavlardan birkaç gün önce
c. 1-2 hafta önce
d. 3 hafta veya daha önce