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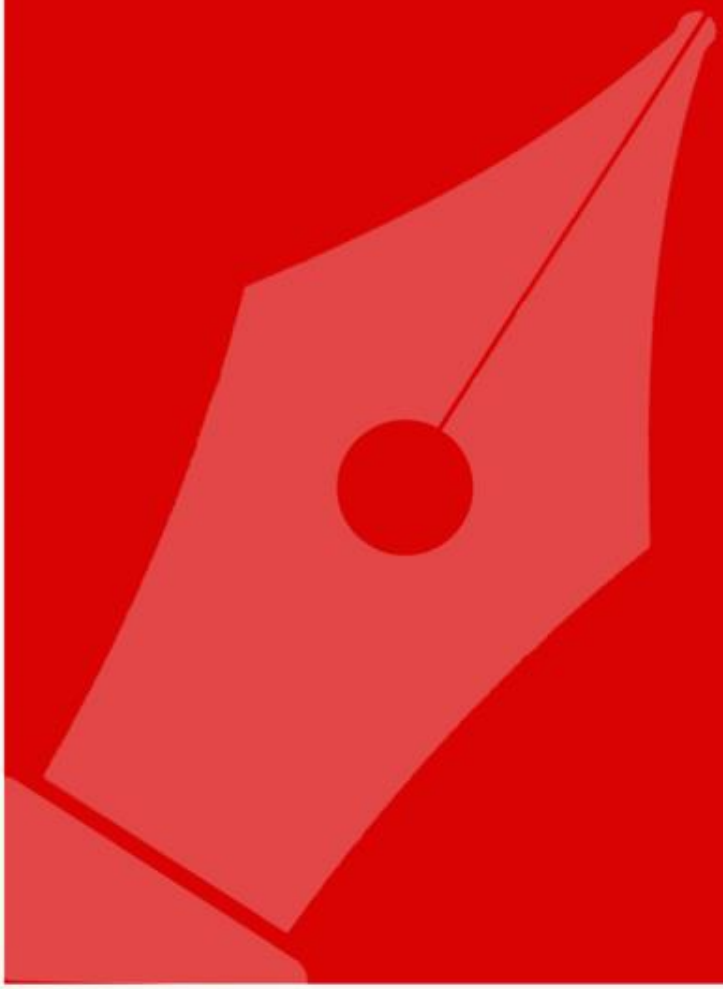

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Examination of Scale Development and Adaptation Studies Published in the Field of Educational Sciences

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Abstract

The aim of this study is to examine the scale development and adaptation studies in the subject area of educational sciences published in TR-index in 2023 in terms of subject area, rotation method, confirmatory factor analysis (CFA) fit indices, number of modifications, type of scale developed, number of items before and after exploratory factor analysis (EFA), number of dimensions, sample sizes and reliability methods. For this purpose, document analysis method, one of the qualitative research designs, was used. A total of 84 scale development and adaptation studies were accessed by examining the issues published in 2023 of 184 journals in the TR-index and listed in the subject area of "Education, educational research", and the final sample was determined as 61 studies by removing 23 scale studies that were not in the field of educational sciences. Of the identified studies, 48 were scale development and 13 were scale adaptation studies. As a result of the research, it was determined that most of the studies were prepared on the subject of competence/self-efficacy, Varimax rotation method was frequently used, CFA fit index values were appropriate, there were no modifications in most of the studies, most of the studies were prepared with a five-point Likert-type scale, the difference in the number of items before and after EFA was not very large, most of the scales consisted of three dimensions, the sample selection was generally 251-500 people and EFA and CFA samples were different, and Cronbach's Alpha method was frequently used as a reliability method. The results obtained were supported by the literature and various suggestions were made.

Keywords: Scale Development, Scale Adaptation, Scale, Scale Review

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INTRODUCTION

Measurement has an important place both in daily life and in scientific studies. Although it is a method of investigation used in all fields of science, measurement processes vary among scientific disciplines. While the variables observed in natural sciences are concrete and obsevable, they are abstract in the field of social sciences, and therefore indirect measurement is carried out in the field of social sciences. (Baykul, 2000; Özgüven, 2011). Indirect measurement is the measurement of a characteristic through another characteristic (Güler, 2011). Throughout history in the field of social sciences, the development of different theories has led to the emergence of various approaches in the field of measurement, but fundamentally, psychometric and impressionistic approaches stand out (Cronbach, 1960 as cited in Çüm and Koç, 2013). Cronbach (1960) stated that the psychometric approach is more objective, easier compared to other data collection methods, allows for objective scoring, and enables valid and reliable observations, hence its effects are seen in research across different fields (as cited in Çüm and Koç, 2013).

For a measurement, there must be the measured, the measurer, instruments, and rules managing the relationships between these three. The measured is defined as the characteristics of everything that exists and occupies space in the empirical world; therefore, things that are not directly or indirectly observed cannot be the subject of measurement (Erkuş, 2019). When a measurement instrument is developed or adapted, those conducting the measurement process must provide information regarding the psychometric properties of the scale if it is used for purposes other than its original development or with a different sample. Not providing this information will make the data obtained from this measurement process questionable (Şekercioğlu, 2023). Even the most complex analyses within the field of statistics rely on measures of similarity (central tendency) and difference (variation) (Erkuş, 2019).

In order to measure human characteristics, it is necessery to classify these characteristics as physical, psychological, biological, and physiological. Psychological characteristics are also divided into cognitive, affective, and behavioral aspects. Cognitive characteristics involve the processes of information processing following the reception of internal or external stimuli; affective characteristics encompass attitudes, interests, personality traits, and emotional features such as love, hate, like, and anxiety; and behavioral characteristics refer to observable behaviors exhibited by individuals. If the structure of psychological characteristics is found out, then the appropriate measurement methods can also be determined. In the field of psychology, scales are used to measure variables such as anxiety, attitudes, personality, motivation, values, and interests while collecting data. The measurement of concepts that cannot be directly observed or measured, but can be measured through observable variables, is defined as psychological measurement (Dirlik, 2013).

Scale development is defined as *the process of creating a set of stimuli that will only stimulate the relevant characteristics intended to be measured in an individual and forming response categories suitable for these stimuli* (Erkuş, 2019). In a developed scale, the process involves determining how much of the measured attribute is represented by the individual's responses, while scale development entails structuring the items that will reveal what these characteristics are. The starting point in scale development is theories and conceptual foundations; when these are flawed, it means the scale has also been developed erroneously. Therefore, the scale development process, as it influences the decision-making process about individuals, is a serious and demanding endeavor (Erkuş, 2019).

When the literature is examined, it is observed that there is a significant amount of work on the development and adaptation of psychological tests in our country. The lack of institutions to provide support for researchers in terms of measurement tools in our country causes researchers to experience difficulties in accessing valid and reliable scales. Therefore, they feel compelled to either adapt a scale developed abroad or develop a new scale. To develop or adapt a scale, it is necessary to have a detailed information of the subject matter and to be familiar with the standards related to the scale (Edenborough, 1999). Researchers who wish to adapt or develop a scale must have a thorough understanding of the characteristics and structure of the variable they intend to measure (Cohen and

Serdlik, 2010). Otherwise, the scale developed without considering the stages of scale adaptation or development may become a scale that poses risks for scientific research. As a result, the time and effort spent on research using this scale may go to waste, and furthermore, the information obtained from these scales, which will be included in the literature, can lead to information pollution and situations that negatively affect the lives of individuals in the research population (Çüm and Koç, 2013).

A researcher aiming to conduct scale development needs to follow eight steps (DeVellis, 2003). Firstly, they must determine what they want to measure and establish the theoretical framework related to the concept they want to measure. Secondly, they need to create an item pool. Then, in sequence, they should decide on the formate of the measurement tool, have the items in the item pool reviewed by experts, conduct item validations, carry out a preliminary application of the scale, evaluate the items based on the application results, and create the final form of the scale (Şahin and Boztunç Öztürk, 2018). Various methods can be used when creating the item pool. If a directly measurable behavior is to be assessed, the observation method can be used; if theory is to be employed, a review of the literature can be conducted; if attitudes are to be measured, a sample close to the population is asked to write a composition (Erkuş, 2019). When creating an item pool, preparation should be done by considering all dimensions of the subject (Tezbaşaran, 2008). The type of measurement tool should be decided by taking into consideration how the results will be interpreted. Choosing the most suitable type of measurement tool from various types such as Thurstone, Guttman, Likert, etc., is important at this stage (DeVellis, 2003). During the stage of content validity, expert opinions are consulted to assess the representativeness and coverage validity of the items (Erkuş, 2003; Yurdugül, 2005). After determining item adequacy, validity and reliability are assessed by applying them to the sample group. It is crucial to determine the sample size very well at this stage. When a small sample size is used, internal consistency issues may arise (DeVellis, 2003). After the validity and reliability study, the scale becomes ready in its final format. Taking all these stages into account, it is obvious that scale development and scale adaptation are demanding and laborious tasks. Therefore, researchers need to be very meticulous.

The steps to be followed in scale adaptation studies have been established by examining studies by the World Health Organization. The researcher conducting scale adaptation must first translate the scale. For the translation to be done correctly, the translator must also be familiar with the culture in which the scale was developed. During translation, attention should be paid to conceptual equivalence, simple and clear expressions should be used, and the characteristics of the group that will respond to the scale should be taken into account. After translation, expert opinions should be sought to correct any missing or incorrect expressions in the translation, the cultural compatibility of the items should be examined, and the conceptual equivalence of the concepts should be scrutinized. Then, the scale should be translated into the target language by a different translator to determine the differences between the original scale and the translated one. This ensures the accuracy of the translation into Turkish. Subsequently, a pilot application is conducted on a similar group for the adaptation study, and the final version of the adaptation study is determined through analyses of this application (WHO, 2017). In scale adaptation studies, the process seeks answers to questions such as the compatibility of the adaptation to the new culture to be used, and how adequate the psychometric properties are, for the scale to be used in a culture other than the one in which it was developed (Deniz, 2007). Fundamentally, scale adaptation studies are a process that often requires repeating many of the steps applied in scale development studies (Şahin, 1994).

When studies examining scale adaptation and development in the literature were investigated; Çüm and Koç (2013) examined scale development and adaptation studies published in the TÜBİTAK Ulakbim database between 2005 and 2013, focusing on the fields of psychology and educational sciences. The research revealed that in 67% of the scale development studies, the steps of scale development were followed, while in 45% of the scale adaptation studies, the steps of scale adaptation were followed. Mor Dirlik (2014) examined doctoral theses on the topic of scale development between 2009 and 2014 to assess the compliance of the scales found in these theses with development standards. Out of a total of five studies, it was concluded that two of them met the standards at a high

level, one met them at a moderate level, and two met them at a low level. Acar Güvendir and Özer Özkan (2015) examined scale development and adaptation studies published in Turkiye between 2006 and 2014. During the examination, the necessary steps in the process were scrutinized, and similarities and differences were identified. As a result of the examination, it was found that Cronbach's Alpha was used in all scales, expert proficiency in both languages was generally employed in scale adaptation studies, adherence to scale adaptation guidelines was not observed, and similarities were generally rare in the articles. Gül and Sözbilir (2015) examined scale development studies conducted in the field of science and mathematics education between 2000 and 2013. As a result of the examination, it was found that the majority of the developed scales were attitude scales, content validity was examined as the validity analysis, and Exploratory Factor Analysis (EFA) was frequently conducted. Delice and Ergene (2015) examined scale development and adaptation studies related to mathematics education published in peer-reviewed journals between 2005 and 2014. As a result of the research, it was found that in most studies, the Cronbach's alpha coefficient exceeded 0.8, there was no significant relationship between sample size and number of items, in some studies, the number of participants per item was less than five, and in scale development studies, scale development steps were applied at a rate of 65%, while in scale adaptation studies, adaptation steps were applied in 53% of the cases.

Şahin and Boztunç Öztürk (2018) examined scales developed in the field of education in Turkey between 2010 and 2016. The scales were examined under the headings of the introduction section of the article, preparation of the item pool, developed form, sample of trial application, and analyses. As a result of the examined articles, it was found that the most common practice during item writing process was literature review, obtaining expert opinions was common, working with groups ranging from 300 to 499 individuals was prevalent, the number of participants per item was mostly between 5 to 9, Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were commonly used together for establishing construct validity, criterion validity was generally not tested, item analysis included item-test correlation, and internal consistency reliability method was utilized. Tekin and Bolat (2018) examined scale development studies related to writing education published between 2006 and 2017. As a result of the examination, it was found that scales were developed on topics such as attitude, anxiety, tendency, self-efficacy, and effect. Scales are generally working with primary school students, these scales are prepared as Likert-type , and using Exploratory Factor Analysis (EFA) most frequently in data analysis, reliability analyses were also conducted. Olgun and Alatlı (2019) examined scale development and adaptation studies targeting adolescents published in Turkiye between 2004 and 2019. In the studies examined, it was found that for scale development; the most common practice during the item writing process was literature review, expert opinions from domain experts were frequently sought, pilot testing was conducted, the number of participants per item was mostly 20 and above, item-test correlation was used for item analysis, Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were used together for validity, and Cronbach's alpha was most frequently used as the reliability method. In scale adaptation studies, it was determined that the most common practice was to consult domain experts and English language experts, pilot testing was not conducted, item-test correlation was used for item analysis, Confirmatory Factor Analysis (DFA) was mostly used as the validity method, and reliability was assessed using Cronbach's alpha and test-retest method. Çelik and Yüksel (2020) examined scales within the scope of music education developed between 1997 and 2019. As a result of the research, it was found that the most common practice was to work with professional music education institutions, predominantly single-dimensional scales were developed, the number of participants per item was insufficient, attitude scales were developed the most, and generally five points Likert-type scales were developed. Cin Şeker and Yücel Çetin (2022) examined scale development studies conducted in the field of reading education. As a result of the examination, it was found that attitude scales were developed most, the studies were conducted with middle school students, Likert-type scales were prepared, both Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were used together, and reliability analysis was also conducted.

In this study, scale development and adaptation studies falling within the field of educational sciences, published in TR-index and released in 2023, were examined. The number of journals

published in TR-index is 1698. Of these journals, 184 are related to "Education, educational research". Considering the scale adaptation and scale development researches published in these journals and the hundreds of research studies conducted using these scales, it is understood that scales prepared without considering the scale adaptation and development stages would cause a significant problem. Despite this situation, it has been observed that there are few studies examining scale adaptation and development in our country. Therefore, this research aims to examine the scale adaptation or development studies published in the journals listed in TR Index under the topic of "Education, educational research" for the year 2023 according to various variables.

METHOD

Research Model

In this study, the method of document analysis, which is one of the qualitative research designs, was used as the research aimed to examine scale development and adaptation studies falling within the field of educational sciences. Detailed examinations and analyses can be conducted with qualitative research, therefore it is not suitable for working with very large sample groups (Yıldırım and Şimşek, 2013). As a result of the analyses conducted, the status of the scale development and adaptation studies was revealed according to the examined standards.

Data Collection and Data Collection Tool

The document analysis method was used to find, read, and evaluate the studies used in the research. For this study, which aims to examine scale development and adaptation studies falling within the field of educational sciences published in TR-Index indexed journals in Turkiye in 2023, journals published on the trdizin.gov.tr website were examined. The studies that will constitute the data of the research were scanned from articles falling into the field of Educational Sciences by entering the keywords "scale development" and "scale adaptation" on the websites of TR Index. A total of 84 scale development or adaptation studies were accessed, resulting in the exclusion of 23 studies that did not fall within the field of educational sciences, thus determining the final sample size as 61. Among the articles included in the analysis, 48 were scale development studies and 13 were scale adaptation studies. The examined articles were coded as S1, S2,..., S61. Although the research included 61 studies, some of them (S11, S49, and S50) contained more than one scale. Therefore, in terms of certain characteristics, the codings for these studies were given as S11A, S11B, S49A, S49B, S50A, S50B, S50C.

The examined studies were analyzed based on the purpose of the scale, EFA rotation method, CFA fit indices, number of modifications, Likert type, number of items, number of items in the item pool, difference in the number of items between the initial and final versions of the scales, number of dimensions, sample size, and reliability methods. The names of journals containing scale development and adaptation studies included in the research are provided in Table 1.

Table 1: Journals containing scale development and adaptation studies

Name of Journal	Frequency
Abant İzzet Baysal University Journal of Education Faculty	1
Adıyaman University Journal of Social Sciences Institute	1
Journal of Mother Tongue Education	3
Ankara University Journal of Faculty of Educational Sciences	2
Bartın University Journal of Education Faculty	2
Bayburt Journal of Education Faculty	2
Buca Journal of Education Faculty	4
Cumhuriyet Uluslararası Journal of Education	4
Çukurova University Journal of Education Faculty	3
Journal of Learning and Teaching in the Digital Age	2
Journal of Educational Technology Theory and Practice	1
Journal of Education and Human Sciences: Theory and Practice	1

Erzincan University Journal of Education Faculty	2
Fırat University Journal of Social Sciences	2
Gazi Journal of Education Faculty	4
Hayef: Journal of Education	2
İnönü University Journal of Education Faculty	3
Journal of Computer and Education Research	1
Kafkas Journal of Education Research	1
Kocaeli University Journal of Education	2
Marmara University Atatürk Education Faculty Journal of Educational Sciences	2
National Education	5
Muğla Sıtkı Koçman University Journal of Education Faculty	1
Pamukkale University Journal of Education Faculty	2
Sakarya University Journal of Education	2
Turkish Journal of Educational Sciences	1
Uludağ University Journal of Education Faculty	1
Van Yüzüncü Yıl University Journal of Education Faculty	1
Journal of Higher Education	1

Data Analysis

The articles used in the research were analyzed by using content analysis method. Content analysis is a method used for understanding and comparing publications. By using content analysis techniques, the contents of a study can be analyzed in depth (Arıkan, 2013). The most important stage in conducting content analysis is the creation of categories that match with the purpose of the research. Through categories, data can be transformed into meaningful information (Yıldırım & Şimşek, 2013). In this study, categorical analysis and frequency analysis were conducted. Categorical analysis and frequency analysis are often used together. Categorical analysis involves dividing content into specific parts and categorizing them according to predefined criteria (Tavşancıl & Aslan, 2001). Researchers have identified categories that align with the purpose of the study based on specific criteria, and tables have been created accordingly. Frequency distributions have been utilized to quantify the obtained data. The SPSS software package has been used for the analysis of this data.

Coding and Reporting of Data

The researchers recorded information about the articles included in the study separately in a finalized form. Subsequently, the information was compared, and discussions were held regarding any differences to reach a consensus.

Validity and Reliability

In this study, importance has been given to the following issues to ensure validity and reliability.

1. The general purpose of the study and research questions have been clearly stated.

2. The selection process of the articles constituting the data of the study has been described in detail.

3. Information about the authors, research titles, and publication details of the articles constituting the data of the study has been provided in a table.

4. To ensure the reliability of data analysis, researchers filled out separate forms and then compared the completed forms. Discussions were held regarding any discrepancies to reach a consensus.

FINDINGS

The findings regarding the distribution of topics of the examined studies are provided in Table 1.

Table 1: Distribution of topics of the examined studies

Purpose	Study Code	f
Competence/Self-efficacy	S2, S7, S25, S28, S32, S33, S43, S53, S55	9
Attitude	S17, S20, S22, S29, S35, S44, S57, S58	8
Literacy	S26, S49, S52, S60, S61	5
Assessment	S1, S12, S21, S59	4
Perception/Self-perception	S27, S39	2
Belief	S19, S51	2
Addiction	S4, S14	2
Participation	S8, S18	2
Organization/Self-regulation	S11, S15	2
Tendency	S30, S34	2
Leadership	S37, S48	2
Behaviour	S42, S45	2
Anxiety, Motivation, Strategy, Awareness, Satisfaction, Commitment, Opinion, Efective Teaching, Skill, Grade, Determination of Education Philosophy, Subect Matter Knowledge, Performans, Active Learning Practices, Immunity, Emphaty, Experinences, Approach, Metacognition	S3, S5, S6, S9, S10, S13, S16, S23, S24, S31, S36, S38, S40, S41, S46, S47, S50, S54, S56	19

When Table 1 is examined, it can be seen that the highest number of competence/self-efficacy (f=9) and attitude (f=8) scales have been developed or adapted. Single studies under sub-topics have been merged. The findings regarding rotation methods of the examined studies are provided in Table 2.

Table 2: Rotation methods of the examined studies

AFA	Study Code	f
Varimax	S2, S3, S4, S10, S12, S13, S16, S17, S18, S20, S22, S26, S29, S31, S32, S33, S36, S38, S39, S47, S49A, S52, S53, S59, S61	25
Geomin	S34, S42, S45	3
Equamax	S37	1
Oblimin	S15, S19, S23, S51, S57, S58, S60	7
Promax	S30	1
No rotation	S5, S43, S49B	3
No AFA	S1, S6, S8, S9, S11A, S11B, S14, S21, S24, S28, S40, S41, S48, S54, S56	15
No Information	S7, S25, S27, S35, S44, S50A, S50B, S50C, S55	9

When the table is examined, it is observed that studies not applying EFA are generally adaptation studies, the most used type of EFA is the Varimax rotation method (f=25), and one of the least used orthogonal rotation methods is the Equamax (f=1), and one of the oblique rotation methods is the Promax (f=1). The examined KMO values range from .79 to .98. The findings regarding the CFAs of the studies included in the research are provided in Table 3.

Table 3: CFA Information of the studies

Fit Indices	Good Fit	f	Acceptable Fit	f	Poor Fit (f)
CMIN/DF (χ^2/sd)	0-3	49	3-5	13	1
RMSEA	.00-.05	7	.05-.08	48	8
CFI	.95-1.00	40	.90-.95	24	-
GFI	.90-1.00	31	.85-.90	10	3
AGFI	.90-1.00	15	.85-.90	21	-
RMR	.00-.05	12	.05-.10	5	-
SRMR	.00-.05	21	.05-.10	22	-
IFI	.95-1.00	22	.90-.95	11	1
NFI	.95-1.00	15	.90-.95	25	4
NNFI (TLI)	.95-1.00	26	.90-.95	17	3
PGFI	.95-1.00	-	.50-.95	8	-
RFI	.95-1.00	6	.90-.95	9	1
PNFI	.95-1.00	1	.50-.95	6	-

When the table is examined, it is observed that many values (CMIN/DF, RMSEA, CFI, GFI, AGFI, SRMR, NFI, TLI) have been examined in more than half of the articles. The most frequently used values are CFI (x=64), CMIN/DF (x=63), and RMSEA (x=63), while the least used values are PGFI (x=8) and PNFI (x=7).

When classifying the fit indices, the criteria proposed by Karagöz (2017), Erkorkmaz et al. (2013) were used as a basis. The fit indices of the scales are classified as follows: for CMIN/DF, the majority (f=49) indicate "Good Fit"; for RMSEA, the majority (f=48) indicate "Acceptable Fit"; for CFI, the majority (f=40) indicate "Good Fit"; for GFI, the majority (f=31) indicate "Good Fit"; for AGFI, the majority indicate "Acceptable Fit"; for RMR, the majority (f=12) indicate "Good Fit"; for SRMR, the majority (f=22) indicate "Acceptable Fit"; for IFI, the majority (f=14) indicate "Good Fit"; for NFI, the majority (f=25) indicate "Acceptable Fit"; for NNFI, the majority (f=26) indicate "Good Fit"; for PGFI, the majority (f=8) indicate "Acceptable Fit"; for RFI, the majority (f=9) indicate "Acceptable Fit"; for PNFI, the majority (f=6) indicate "Acceptable Fit". Furthermore, it has been observed that fit indices falling outside the "Acceptable Fit" range generally have values close to the acceptable fit.

The numbers of modifications occurring in the examined studies is provided in Table 4.

Table 4: Numbers of modifications in the studies

Numbers of modifications	Study Code	f
No Infaormation	S25, S42,	2
No Modification	S1, S2, S5, S7, S8, S9, S10, S11A, S11B, S16, S17, S19, S20, S22, S23, S24, S30, S31, S32, S33, S34, S36, S39, S43, S45, S47, S48, S49A, S50C, S51, S52, S54, S55,S58, S59	35
1-2	S6, S14, S15, S21, S28, S38, S40, S41, S44, S49B, S50A, S53	12
3-4	S3, S4, S12, S18, S26, S29, S37, S46, S56, S61	10
5-6	S50B, S57, S60	3
7-8	-	0
9+	S13, S27	2

When the table is examined, it is observed that in the majority of the studies (f=35), there were no modifications; in studies with modifications, the majority (f=12) had 1-2 modifications. Findings related to the type of scale developed in the studies are provided in Table 5.

Table 5: Type of scale developed in the studies

Likert	Study Code	f
Triple	S17, S19, S20, S49A, S49B, S51	6
Quadruple	S1, S6, S8, S11A, S18, S41	6
Quintuple	S2, S3, S4, S5, S10, S11B, S12, S15, S16, S21, S22, S23, S25, S26, S27, S28, S29, S30, S31, S32, S33, S35, S36, S37, S38, S39, S42, S43, S44, S45, S46, S47, S48, S50, S52, S53, S54, S55, S57, S58, S59, S60, S61	43
Sextuple	S24, S40	2
Septuple	S7, S13, S14, S56	4
No Information	S9	1

All of the examined scales were prepared in Likert type. When the table is examined, it is observed that scales developed or adapted as a result of the research are generally of the five-point Likert scale type (f=43). Additionally, in one article, the type of Likert scale was not specified. The distribution of scales according to the number of items is given in Table 6.

Table 6: The number of items of the scales

The number of items	Study Code	f
0-10	S7, S14, S30, S35, S44, S49B	6
11-20	S2, S4, S6, S8, S9, S12, S15, S16, S17, S19, S20, S22, S24, S29, S34, S39, S41, S42, S43, S45, S48, S49A, S51, S54, S58, S61	26
21-30	S1, S3, S5, S10, S11A, S18, S21, S23, S26, S32, S36, S37, S38, S46, S52, S53, S55, S56, S59, S60	20
31-40	S11B, S13, S25, S31, S33, S40, S47, S57	8
41-50	S27, S28, S50	3

When the table is examined, it is observed that the examined scales are divided into five categories based on the number of items. The majority of the examined scales have a number of items in the range of 11-20 (f=26). Twenty scales fall within the range of 21-30, eight scales fall within the range of 31-40, six scales fall within the range of 0-10, and three scales fall within the range of 41-50. Findings regarding the number of items created before the Exploratory Factor Analysis (EFA) in the examined scale studies are provided in Table 7.

Table 7: Number of Items before EFA

Item Pools	Study Code	f
11-20	S35, S49B	2
21-30	S7, S10, S12, S19, S29, S34, S37, S45, S51, S53	10
31-40	S3, S5, S13, S20, S38, S49A, S59	7
41-50	S16, S17, S26, S28, S30, S32, S46, S47, S61	9
51-60	S4, S23, S53, S33, S42, S55, S60	7
61-70	S2, S36, S50, S58	4
71-80	S15, S39, S57	3
81-90	S52	1
91-100	S25	1
111-120	S22	1

When the table is examined, it is observed that the examined scales are divided into 10 categories in terms of the created item pool. Additionally, it is seen that the number of created item pools is at most in the range of 21-30 (f=10). The difference in the number of items between the scales before and after the EFA is given in Table 8.

Table 8: The difference in item numbers before and after EFA.

The difference in item numbers	Study Code	F
0-10	S3, S5, S10, S13, S19, S28, S29, S35, S37, S47, S49B, S53	12
11-20	S7, S12, S31, S32, S34, S38, S45, S49A, S50, S51, S59	11
21-30	S16, S20, S23, S26, S46, S55, S61	7
31-40	S4, S17, S30, S33, S42, S60	6
41-50	S2, S36, S57	3
51-60	S39, S52, S58	3
61-70	S15, S25	2
101-110	S22	1

When the table is examined, it is observed that the examined scales are divided into eight categories based on the difference in item numbers between their initial and final versions. Additionally, it is noted that the highest frequency of item differences falls within the ranges of 0-10 (f=12) and 11-20 (f=11). The distribution of dimensions formed after EFA in the examined scales is provided in Table 9.

Tablo 9: The number of dimensions formed after EFA

The number of dimensions	Study Code	F
1 Dimension	S5, S7, S14, S15, S19, S25, S30, S35, S43, S49B, S55	11
2 Dimensions	S2, S4, S20, S44, S45, S48, S51, S61	8
3 Dimensions	S6, S8, S12, S16, S17, S26, S29, S32, S34, S37, S39, S41, S47, S49A, S50, S57, S58	17
4 Dimensions	S1, S9, S10, S11A, S11B, S21, S22, S23, S24, S33, S42, S52, S54, S59	14
5 Dimensions	S3, S31, S36, S38, S46, S56	6
6 Dimensions	S18, S27, S60	3
7 Dimensions	S13, S40	2
9 Dimensions	S28	1

When the table is examined, it is observed that the examined scales are divided into eight categories based on the number of dimensions. Additionally, it is noted that the maximum number of dimensions is 3. (f=17).

When the table is examined, it is observed that of all the scales, 17 of them have three-factor, 15 of them have four-factor, 11 of them have one-factor, 8 of them have two-factor, 6 of them have five-factor, 3 of them have six-factor, 2 of them have seven-factor, and 1 of them has nine-factor. The findings regarding the sample sizes of the examined scales are presented in Table 10.

Table 10: The sample sizes of the scales

Total sample sizes	EFA-CFA Sample	Study Code	f
1-250	EFA-CFA same sample	S7, S55, S59	3
	EFA-CFA different sample	-	-
	Only CFA	S8, S18, S21, S24	4
	No Information	S49A, S49B	2
251-500	EFA-CFA same sample	S20, S22. S31	3
	EFA-CFA different sample	S2, S5, S10, S12, S27, S29, S33, S38, S43, S46, S58	11
	Only CFA	S1, S6, S9, S11B, S28, S54, S56	7
	No Information	S13, S40, S41, S44, S48	5
501-750	EFA-CFA same sample	S15	1
	EFA-CFA different sample	S4, S19, S23, S25, S34, S36, S42, S45, S51, S53, S57, S60	12
	Only CFA	S11A, S14	2
	No Information	S52	1
751-1000	EFA-CFA same sample	-	-
	EFA-CFA different sample	S3, S16, S30, S32, S35, S37, S39	7
	Only CFA	-	-

	No Information	-	-
1001-1250	EFA-CFA same sample	-	-
	EFA-CFA different sample	S17, S26, S50, S61	4
	Only CFA	-	-
	No Information	S47	1

When the table is examined, it is observed that the majority of the samples consist of 251-500 individuals (f=26) and generally, the EFA sample differs from the CFA sample. It is noted that different samples are not used for EFA and CFA for the sample groups of 1-250 individuals. Additionally, information regarding the EFA and CFA samples was not found in nine studies. The reliability methods and distribution ranges used in the scales are provided in Table 11.

Tablo 11: The reliability methods used for the Scales

Reliability Method	Value	Study Code	f
Cronbach Alfa	$0.6 \leq \alpha < 0.7$	S44, S47	2
	$0.7 \leq \alpha < 0.9$	S1, S6, S8, S10, S11A, S11B, S14, S17, S18, S20, S22, S23, S24, S30, S32, S34, S35, S39, S41, S42, S46, S49A, S49B, S50A, S50C, S59	26
	≥ 0.9	S2, S3, S4, S5, S7, S9, S12, S13, S15, S16, S19, S21, S25, S26, S27, S28, S29, S31, S33, S36, S37, S38, S43, S45, S48, S50B, S51, S52, S53, S54, S55, S56, S57, S58, S60, S61	36
McDonald's	$0.80 \leq \omega < 1$	S5, S8, S15, S34, S37, S40	6
Test split-half	0.80, 0.89	S23, S29	2
Compound Reliability	0.96	S48	1

When examining the table, it was found that only one article did not calculate at Cronbach's Alpha coefficient, while Cronbach's Alpha coefficient was calculated in all other articles; approximately one-tenth of them calculated McDonald's coefficient. In addition to these, test split-half was utilized in two articles, and compound reliability was examined in one article. Furthermore, it was observed that in four studies where the Cronbach's Alpha method was used (C11B, C18, C24, C35), the reliability coefficient for the entire scale was not provided.

DISCUSSION AND RESULTS

When the scales derived from scale development and adaptation studies in the field of educational sciences published in journals indexed in TR Index in 2023 were examined, it was observed that there were the highest number of studies on attitude and competence/self-efficacy scales, while studies on other topics remained limited in number. Findings regarding the abundance of attitude scales were also reached in the studies conducted by Tosun and Taşkesenligil (2014), Gül and Sözbilir (2015), Tekin and Bolat (2018), Çelik and Yüksel (2020), and Cin Şeker and Yücel Çetin (2022). The abundance of attitude scales can be explained by their wide range of applications (Cin Şeker and Yücel Çetin, 2022). Additionally, being a frequently researched variable makes the development of attitude scales in different areas important. The diversity of scale themes is viewed positively in the field of educational sciences.

When examining the EFA data, it was observed that in a large portion of adaptation studies, EFA was not conducted. Orçan (2018) stated that conducting only CFA in adaptation studies could lead to some problems. It has been stated that in case of a translation-related error, conducting only CFA may lead to a result different from what is normally expected, and the model may exhibit a wrong fit. Additionally, it has been indicated that EFA should be conducted to detect possible errors that may arise considering that the dataset may fit with multiple CFAs, and to identify cultural differences (Orçan, 2018). Contrary to the findings of our study, Boztunç, Öztürk, Eroğlu, and Kelecioğlu (2014) and Çüm and Koç (2013) determined in their researches that in scale adaptation studies, more often EFA is conducted instead of CFA. In scales where EFA is applied, the Kaiser-

Meyer-Olkin (KMO) coefficient was initially examined. The KMO coefficient provides information about whether the data in the scale are suitable for factorization, and it is expected to be greater than 0.6 (Yılmaz and Altınkurt, 2013). Field (2009) considers the KMO coefficient to be good if it falls between 0.7 and 0.8, very good if it falls between 0.8 and 0.9, and excellent if it is above 0.9. In the articles examined within the scope of our research, the KMO values ranged from 0.79 to 0.98, indicating that all studies were suitable for factorization. It is observed that rotation process is mostly used in the articles. Since rotation process facilitates the interpretation of factors, the use of these methods has been considered natural. The rotation process is applied in two ways: orthogonal rotation and oblique rotation (Gül and Sözbilir, 2015). In the assumption that factors are unrelated, orthogonal rotation is used, while in the assumption that factors are related, oblique rotation methods are used (Yurdabakan and Çüm, 2017). Among the articles examined in the study, it is observed that the Varimax method, which is one of the most used orthogonal rotation methods, is utilized the most. Büyüköztürk (2002) has stated that both orthogonal and oblique rotation methods give similar results, but due to the ease of interpretation in orthogonal rotation, this method is frequently used. However, Byrne (2001) has expressed that although interpreting orthogonal rotation methods may be easier, oblique rotation methods are more appropriate in behavioral sciences. However, Kim and Mueller (1978) did not see any drawback in using orthogonal rotation method when the purpose of the rotation process is to interpret the relationship between items and factors. Therefore, the predominant use of orthogonal rotation method in the articles included in the research has been interpreted as a common practice.

When examining the findings regarding CFA information, it was found that there was no information indicating CFA in only one study, while CFA was applied in all other studies, and fit indices were largely considered. The overall index values of the scales were generally in the "Good Fit" range; it was determined that the number of studies falling outside the ranges of Good Fit and Acceptable Fit values was very few, and these values are generally close to the "Acceptable" fit value. Researchers make decisions solely based on the p-value when conducting a χ^2 analysis or t-test, but for CFA, the decision on whether the model is consistent with the theory is based not on a single value but on the values of various fit indices. Even if the factor loadings of the items are good when the model is constructed, this fit may not be sufficient in the fit indices. Due to the wide variety of fit indices, a standard value has not been accepted (Munro, 2005; Şimşek, 2007). When the fit index values examined in the scales are compared with the literature, it has been found that the χ^2/df ratio is the mostly analyzed at fit index in researches (Munro, 2005). Each fit index has a different characteristic; for example, while the RMSEA value measures the approximate fit of the model in the population, the GFI value determines to what extent the model measures the covariance matrix in the sample. The AGFI value is used to address the issues encountered by the GFI test in high sample sizes, while CFI determines the difference between the model assumed with no relationship between variables and the null model (Çokluk, Şekercioğlu, & Büyüköztürk, 2010). Therefore, it is considered important in research to examine multiple fit indices to confirm the model.

When examining the number of modifications applied in the scales, it is observed that this variable is categorized into seven categories. While most studies do not have any modifications, this is followed by 1-2 modifications and 3-4 modifications. Gökdemir and Yılmaz (2023) stated that modifications should be made when model fit is not achieved, but the number of modifications should be limited to three. On the other hand, Gürbüz and Şahin (2018) recommend conducting EFA when structural validity and factorial validity are not achieved, even if an acceptable number of modifications are made. In this regard, it is believed that scales with more than three modifications are not considered to be reliable measures in this study.

It has been determined that all scales use the Likert type as the data collection tool. Tezbaşaran (2008) stated in his study that the Likert type is commonly used due to its usefulness and its ability to increase the level of grading. These scales are categorized into six types of Likert scales. It has been determined that the majority of the studies are prepared using a five-point Likert scale. This finding is consistent with the results obtained from the scales examined by Tekin and Bolat (2018), Çelik and Yüksel (2020), and Cin Şeker and Yücel Çetin (2022).

The scales examined within the scope of the research are categorized into five groups based on the number of items. It has been observed that the majority of the examined scales have studies with item counts of 11-20 and 21-30. No study was found in the research where the number of items was not provided. In a study examining scale development studies used in music education by Çelik and Yüksel (2020), it was also found that the most common scale studies included 11-20 and 21-30 items.

The difference between the item pool and the final number of items in the scales is categorized into eight groups. It has been observed that the most common item elimination occurs in the ranges of 0-10 and 11-20 items. Similarly, in the scale studies examined by Çelik and Yüksel (2020), it was determined that the highest number of eliminated items fell within the range of 0-10 and 11-20. Tezbaşaran (2008) stated that it is necessary to create a pool of items three to four times the number of items intended to be used in the final form. This way, there will be a higher chance of selecting items that achieve the desired discrimination. Among the examined scales, a small number of scales with item count differences of 51-60, 61-70, and 101-110 were encountered. In these scales, the number of items in the item pool exceeds three to four times the number of items in the final form. Such a large gap between the item pool and the final form may suggest that the rules of scale preparation have not been followed carefully.

The dimensions of the scales are categorized into eight groups. It has been determined that the scales with the highest number of dimensions are three-dimensional, four-dimensional, and one-dimensional. This finding is consistent with the study conducted by Çelik and Yüksel (2020).

The scales are categorized into five groups based on sample size. It has been observed that research is most commonly conducted with a sample size of 251-500 participants. When examining the sample size for EFA and CFA studies, it was determined that in sample groups of 251-500, 501-750, 751-1000, and 1001-1250 participants, different samples were mostly used for both EFA and CFA. However, in sample groups of 1-250 individuals, it was found that either separate samples were used for EFA and CFA, or only CFA was conducted. Gül and Sözbilir (2015) found that nearly half of the articles they examined had sample sizes ranging from 301 to 500, while about a quarter had sample sizes of 300 and below. Çelik and Yüksel (2020) determined that the sample sizes of the scales they examined were mostly in the ranges of 101-200 and 201-300. There are similaties between these findings and the findings of our research. Having a large sample size has a positive effect on increasing the validity and reliability of studies. In their study, Tosun and Taşkesenligil (2014) mentioned that the sample sizes commonly used in scale development studies were often between 101-200 participants. Selecting a small sample size can negatively affect the validity and reliability of scale development (Delice, 2010). When comparing the sample sizes and the number of items in the scale development and adaptation studies examined in our research, it was observed that the sample size exceeded five times the number of items for all studies. This finding is consistent with the view in the literature, which suggests applying a sample size of at least five times the number of accepted and available items (Tavşancıl, 2002).

In research, it can be observed that the reliability method commonly used is Cronbach's Alpha (f=64). As known, Cronbach's alpha is a single-application method and may be preferred due to requiring less effort and time compared to methods based on two applications (Gül and Sözbilir, 2015). Additionally, it can be said that it is a correct choice due to its suitability for assessing reliability in Likert-type scales (Çüm and Koç, 2013). Çüm and Koç (2013) determined that approximately 67% of the scales they examined used Cronbach's alpha as the measure of internal consistency.

According to Yang and Green (2011), the reason of the frequent use of Cronbach's alpha coefficient is its ease of interpretation and not requiring personal judgments. When the literature reviewed, it has been determined that for the Cronbach's alpha coefficient to be used, the assumption of equality of item factor loadings must be met. However, it is noted that it is not easy to ensure that all items have equal factor loadings, and in cases where factor loadings are not equal, it is more appropriate to use McDonald's omega coefficiency (Yurdugül, 2006). When examining studies that

utilize both reliability methods, the close results between the two coefficients indicate that the methods used have been appropriately chosen. Cronbach's alpha coefficient distributions are categorized according to the criteria established by George and Mallery. According to these criteria, if the reliability coefficient is $\alpha < 0.5$, it is considered "Unacceptable"; in the range of $0.5 \leq \alpha < 0.6$, it is "Weak"; in the range of $0.6 \leq \alpha < 0.7$, it is "Acceptable"; in the range of $0.7 \leq \alpha < 0.9$, it is "Good"; and if $\alpha \geq 0.9$, it is interpreted as "Excellent" (George and Mallery, 2003). Among the examined studies, it is observed that 36 studies can be interpreted as "Excellent", 26 as "Good", and 2 as "Acceptable" based on Cronbach's Alpha coefficient. Additionally, according to the classification determined by Özdamar (2002), if the reliability coefficient is between $0.61 < \alpha < 0.80$, the scale is considered to have moderate reliability, and if it is between $0.81 < \alpha < 1.00$, it is considered to have high reliability. According to this classification, all the examined scales do not pose a problem in terms of reliability. In the examined studies, scales in S11B, S18, S24, S35, and S59 did not provide an overall reliability coefficient for the scale, but they only provided reliability coefficients for their dimensions. Additionally, in some studies, multiple reliability methods have been examined, aiming to prevent possible errors by using multiple reliability methods.

Based on the results obtained from the study, several recommendations have been proposed for future scale development or adaptation studies. These recommendations are as follows:

A comprehensive guidebook should be published for future scale development and adaptation studies, and researchers should meticulously adhere to the stages outlined in this guidebook during the process of scale development or adaptation. A center should be established in our country for the preparation and control of scale development and adaptation studies. Researchers intending to develop or adapt scales should not repeat the steps followed in previous studies without thorough investigation. It should be remembered that repeating a mistake can lead to even greater problems. Researchers should have detailed knowledge of different validity and reliability methods and should use the most suitable method for their research. Courses related to scale development and adaptation should be added to postgraduate education to enable researchers to obtain accurate information from reliable sources.

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An Examination of the Relationship Between Reading Culture and Mathematical Literacy Self-Efficacy of Pre-Service Teachers

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Abstract

The aim of this study is to examine the correlation between reading culture and the mathematical literacy self-efficacy among pre-service teachers and assesses these variables in relation to several factors. Utilizing convenience sampling, the research sample consists of 562 pre-service teachers studying in mathematics and primary school teaching programs in seven different universities. Data was gathered using the Reading Culture and Mathematical Literacy Self-Efficacy Scales, along with a personal information form. Both descriptive and inferential statistical methods were employed to analyze the data. Results revealed a significant but low-level correlation between reading culture, its sub-dimensions, and mathematical literacy self-efficacy levels among pre-service teachers. Notably, pre-service teachers engaging with scientific books demonstrated higher mathematical literacy self-efficacy than those preferring literary books. In addition, pre-service teachers' scores of mathematical literacy self-efficacy and reading culture are not independent of the department they study in. Reading culture, gender, and department were significant predictors of mathematical literacy.

Keywords: Mathematical Literacy, Reading Culture, Reading Habit, Self-Efficacy

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INTRODUCTION

Mathematics is more than just a subject; it's an indispensable discipline that arms students with practical skills necessary for daily life and cultivates their problem-solving skills, crucial for any future career (Draper & Siebert, 2004). It's a key to academic success (Shaul & Schwartz, 2014) and life achievements. A solid mathematical background isn't just about number crunching; it involves interpreting quantitative information, applying critical and creative problem-solving strategies - skills that are essential for high-level thinking and success in the real world (Villa & Sebastian, 2021). These skills are at the heart of mathematical literacy, enabling one to grasp, interpret, and critically engage with mathematical concepts across diverse settings (İlhan et al., 2019; Yore et al., 2007).

One effective approach to mastering mathematics is through reading and writing (Draper & Siebert, 2004). Reading doesn't just enrich personal, social and academic development; it's intricately linked with acquiring life skills, literacy, and fundamental mathematics capabilities (Ruterana, 2012; Yıldız, 2010). As Gomez et al. (2020) point out, reading is crucial in deciphering mathematical problems. It fosters comprehension and reading comprehension allows learners to make connections and solve real-world problems by merging language understanding with mathematical concepts. This synergy is crucial; reading is a lifelong skill that intersects with every aspect of life, including mathematics.

The nexus between reading and mathematical literacy is complex and multifaceted. Studies reveal that reading literacy and mathematics share similar cognitive demands (Netten & Droop, 2010). Mathematical performance has been found to predict progress in reading comprehension among young students (Lerkkanen et al., 2005). Additionally, the interplay between word decoding, reading comprehension, and mathematics skills suggests a deeper, intertwined development of these areas (Harlaar et al., 2012). Moreover, students' motivation to study mathematics and their reading significantly influence their mathematical comprehension (Prabowo et al., 2023). The positive relationship between self-efficacy in mathematical literacy and beliefs about mathematical problem-solving highlights the profound impact of self-efficacy on mathematical literacy (Sezgin-Memnun et al., 2012). Mathematical literacy self-efficacy (MLS-E), referring to an individual's belief in their capacity to deal with mathematical processes and situations, plays a significant role in shaping students' mathematical literacy skills and problem-solving abilities (Pajares & Miller, 1994; Özçakır-Sümen & Çalışıcı, 2016).

Acknowledging that mathematical literacy is as crucial as reading/language-based literacy in the curriculum (McCrone & Dossey, 2007), it becomes imperative to ignite students' interest in reading, foster positive attitudes towards reading, and cultivate consistent reading habits (Alex-Nmecha & Horsfall, 2019; Marzuki & Rusmar 2017). Clearly, reading culture (RC) and mathematical literacy are pivotal in the educational process. Given their parallel roles in the curriculum, it's plausible to suggest an indirect link between MLS-E and RC. Pre-service teachers' unique position as future educators places them at the forefront of applying these skills not only for their personal and professional development but also for shaping the educational experiences of their future students. Pre-service teachers, therefore, become key agents in bridging MLS-E and RC within our educational systems. As they develop these competencies, they are better equipped to foster a similar culture of literacy and mathematical self-efficacy in their classrooms (Schnulz, 2005). Consequently, gaining a deeper understanding of the interplay between MLS-E and RC in the context of pre-service teachers is not just beneficial but essential for the advancement of educational practices and student success in both mathematics and reading.

Conceptual Framework

Reading culture

Cognitive, social, and linguistic development are fundamentally underpinned by thinking -a crucial skill- that is nurtured by reading. Reading, defined as the act of deciphering written texts to

construct meaning (Harvey & Goudvis, 2017), serves as a pivotal learning activity. It equips individuals with critical thinking skills (Deale & Lee, 2021), nurtures novel perspectives, fosters self-understanding and worldly comprehension, and aids in interpreting future events and situations (Karadeniz & Can, 2015). Engaging with texts is the starting point for developing a broader RC.

As reading transitions from a skill to a culture, it becomes the foundation of knowledge acquisition (Yang & Yu, 2014) and a key contributor to learning (Igwe, 2011). RC, extending beyond mere skill, plays a significant role in academic achievement (Palani, 2012). The text-based nature of most curricula underscores the critical role of reading skills in boosting academic performance and fostering positive learning outcomes (McGeown et al., 2015). Therefore, nurturing a RC involves increasing individuals' interest in reading, facilitating the formation of reading habits, and fostering a positive attitude towards reading.

Developing a strong RC is particularly crucial for pre-service teachers, as it significantly influences their future roles as educators (Aramide, 2023; Azmi, 2013; Bardelli et al., 2023; Bilavych & Rozman, 2016). This aspect of their training is vital not only for their personal and professional growth but also for their ability to foster similar values in their future students. Kekeeva et al. (2020) developed a ''Reading Culture Scale'' to assess the RC of pre-service teachers, underlining the importance of this skill in their professional development. Altun (2018) explored developing RC through collaborative workshops and educational role plays.

RC impacts not just language lessons but achievement across all academic fields and life in general (Altunkaya & Doğar, 2018). It encompasses components such as reading interests, habits, and attitudes (Kuşdemir et al., 2020). Reading interests pertain to personal preferences in genres and topics such as fiction books, help individuals develop positive attitudes towards reading when they engage with texts that align with their interests (Ajello et al., 2018; Ho et al., 2022; Hopper et al., 2005; Manuel & Carter, 2015). Conversely, a lack of interest in reading can negatively impact reading comprehension (Orellana et al., 2020). Arofah and Ningsi (2001) argue that reading interest significantly influences learning outcomes due to its role in the learning process. The integration of digital materials, such as audiobooks, e-books and online journals, has become increasingly prevalent among students, indicating a shift towards digital mediums that could potentially enrich reading habits (Ajayi et al., 2014; Tattersall-Wallin & Nolin, 2020). However, they also highlight the significance of being aware of technology-related challenges, such as inadequate internet access and a deficit in digital literacy, which may hinder the full realization of these resources' benefits for enhancing RC. Reading habits, cultivated through repetition and eventually becoming permanent, are reflected in the amount of material read, frequency of reading, and average time devoted to reading (Chettri & Rout, 2013). These habits significantly impact students' academic achievement (Balan et al., 2019). Attitudes towards reading, defined as underlying feelings and beliefs about reading that drive reading behaviour (Ho et al., 2022; McKenna & Kear, 1990), are critical determinants of reading success. Reading culture encapsulates the beliefs and values that shape attitudes, expectations, habits, and prejudices towards reading and books (Pečjak, 2021). Individuals demonstrate a RC when they select and consistently engage with books and other knowledge-based materials aligned with their interests and abilities (Kamalova & Koletvinova, 2016; Maldybaevna et al., 2022). This emphasis on cultivating a robust RC is expected to not only enhance the pedagogical skills of pre-service teachers but also prepare them to effectively nurture literacy and a love for reading in their future classrooms. Fostering a RC involves understanding and enhancing these elements, which can lead to improved learning outcomes and a deeper engagement with various subjects (Türkel et al., 2019). In line with this, RC among pre-service teachers not only impacts their personal and professional growth but also sets the stage for their future roles as educators in fostering a similar culture among their students.

In conclusion, the literature provides valuable insights into the various factors influencing the RC of pre-service teachers, including their competence, critical reading skills, attitudes, and cultural awareness. These findings can inform the development of effective strategies and interventions to promote a strong RC among pre-service teachers, ultimately enhancing their capacity to foster literacy skills in their future students.

Mathematical literacy and mathematical literacy self-efficacy of pre-service teachers

In an era marked by rapidly expanding knowledge, the development of diverse skill sets, including information literacy, technology literacy, and particularly mathematical literacy, has become imperative for individuals, especially pre-service teachers. Mathematical literacy, which denotes the capacity to effectively utilize mathematical knowledge and navigating in daily life complexities (Steen et al., 2007), is fundamental for these future educators. This literacy involves not just basic computation but also reasoning, analyzing, formulating, and problem-solving within real-world contexts (Aydoğan-Yenmez & Gökçe, 2023). This form of literacy empowers pre-service teachers to apply a broad spectrum of mathematical content, meeting both personal and societal demands, thereby participating in society as informed, reflective, and contributing citizens (Geiger et al., 2015).

Beyond traditional mathematical boundaries, mathematical literacy encompasses social, cultural, political, psychological, economic, historical, and societal dimensions (Vithal & Bishop, 2006). For preservice teachers, this means that enhancing mathematical literacy skills involves integrating knowledge from various disciplines—such as history, geography, economics, biology, agriculture, culinary arts, and social studies—with the prerequisite knowledge and skills from mathematics classes (McCrone & Dossey, 2007; Steen et al., 2007). Central to this interdisciplinary approach is the role of reading skills, which are pivotal in acquiring the necessary background knowledge for success in mathematics and other academic subjects (Erbeli et al., 2021; Reinke et al., 1997; Sullivan & Brown, 2015). These insights underscore the potential of an interdisciplinary approach to fostering mathematical literacy, with a RC playing a substantial role in the acquisition and development of mathematical literacy skills. Additionally, case studies assessing mathematical literacy among pre-service elementary school teachers highlight the need for targeted training to address varying proficiency levels (Yustitia et al., 2020).

Self-efficacy, or one's belief in their capabilities in a specific area (Bandura, 1986), plays a critical role in the professional development of pre-service teachers. High self-efficacy in mathematical literacy is crucial for pre-service teachers, as it directly affects their confidence and effectiveness in teaching mathematics (Cheema, 2018). However, this self-efficacy must be aligned with actual proficiency in mathematics to ensure meaningful and impactful teaching (Ali et al., 2023). The development of MLS-E in preservice teachers is a multifaceted process, influenced by various factors such as their attitudes towards mathematics, their educational experiences, their perceptions of subject knowledge, and their broader skill perceptions, and gender (Akçay et al., 2022; Altıntaş et al., 2012; Arslan & Yavuz, 2012; Ayvaz Can, 2019; Önal et al, 2017; Özçakır-Sümen & Çalışıcı, 2016; Zehir & Zehir, 2016). Studies also reveal that preservice teachers' MLS-E crucially influences their teaching effectiveness, particularly in applying mathematical concepts through problem-posing and critical thinking skills (Akçay et al., 2022; Sezgin-Memnun et al., 2012). Challenges in developing these skills, such as varying educational backgrounds and preconceived attitudes towards mathematics, require comprehensive solutions. Teacher training programs must incorporate strategies that address these challenges, providing tools and resources to build both competency and confidence in future educators.

In conclusion, fostering mathematical literacy and MLS-E in pre-service teachers is paramount for their effectiveness as mathematics educators. This development is influenced by interdisciplinary learning, self-belief, and practical application of mathematical concepts. Teacher training programs, therefore, should focus on these aspects, equipping future educators with the necessary skills and confidence to promote mathematical literacy and MLS-E in their students, preparing them to meet the demands of a rapidly evolving educational landscape.

Reading culture and mathematical literacy self-efficacy

The complex relationship between the RC and MLS-E is supported by a comprehensive framework that highlights the interaction between the fundamental skills of RC (i.e. individual development reading relationship, basic reading skill, visual reading, book selection) and their

subsequent impact on one's confidence in mathematical literacy proficiency. This crucial relationship is further clarified by Whitehurst & Lonigan (1998), who highlight the pivotal role of emergent literacy skills in reading development and their impact on mathematical self-efficacy. Similarly, Oakhill et al. (2003) discuss the dissociation of word reading and text comprehension, pointing out the diverse skill sets contributing to variations in reading abilities. In a study by Kyttälä & Björn (2014), the relationship between students' literacy skills and their math problem-solving skills was investigated, revealing a strong link between literacy skills and math word problem-solving skills. Moreover, the positive correlation between visual math literacy self-efficacy and visual mathematics accomplishment, as delineated by Duran & Bekdemir (2013), along with the exploration of mathematical literacy levels and self-efficacy perceptions by Katrancı & Şengül (2019), reinforces the significance of visual components in MLS-E. Walkington et al. (2018) propose that reading achievement scores might be more precise predictors of mathematics achievement than some commonly employed metrics. Valencia et al. (2023) found that reading comprehension is a predictor of maths proficiency, further supporting the critical role of reading in developing mathematical literacy.

Each element of RC directly influences mathematical literacy aspects, enhancing problem-solving and conceptual application. Furthermore, the influence of basic cognitive processing, such as visual-spatial perception, and the utilization of mathematical language in instruction on MLS-E are documented by Lambert et al. (2020) and Karademir & Deveci (2019), respectively. Marzuki and Rusmar (2017) have explored the impact of reading and study habits on students' learning achievement in mathematics. Additionally, Shepps and Shepps (1971) examined the connection of study habits and school attitudes with achievement in mathematics and reading, and Yang and Yu (2014) established reading as a crucial tool for learning mathematics. Implementing a rich RC can significantly boost MLS-E, suggesting a need for diverse reading integration in education.

Interdisciplinary research (Bernabini et al., 2021; Biscevic et al., 2021; Cameron et al., 2019; Hadianto et al., 2020; Hübner et al., 2022; Öztop & Toptaş, 2022; Purpura et al., 2011; Supontawanit & Lertlit, 2021), illuminate the robust relationship between reading and mathematics skills. In particular, Karacaoğlu & Kasap (2023) identify reading comprehension as fundamental for mathematics achievement. The importance of reading interest and study habits on mathematics learning outcomes is further supported by Arofah and Ningsi (2021), and Eby (2016) underscores the direct link between reading and mathematics success through the utilization of literacy in mathematics classrooms via word problems and math stories. Acknowledging the influence of educational, cultural, and curricular differences on these findings highlights the need for further, diverse studies to fully understand the reading-mathematics dynamic.

The collective insights from these studies underscore the premise that a robust RC is paramount for enhancing MLS-E. This connection is further evidenced by the direct predictor role of reading performance on mathematics success (Hadianto et al., 2020), suggesting that individuals with rich reading comprehension skills are likely to exhibit higher MLS-E. Although the exploration into the correlation between reading skills and mathematics achievement is extensive (Schunk et al., 2022), it often misses a direct examination of their association with RC and MLS-E, presenting a nuanced avenue for inquiry. Villa and Sebastian (2021) suggest that factors such as motivation and study habits are instrumental in explaining mathematics achievement, proposing that a student's engagement in a RC could significantly influence their mathematical literacy levels, either positively or negatively. This perspective is supported by Arofah and Ningsi (2021), who found that an increase in reading interest markedly improves mathematics learning outcomes, indicating the potential predictive value of the RC variable on MLS-E.

Aim of the study

The aim of this study is to investigate the relationship between RC and MLS-E levels among pre-service teachers and to analyse these variables in terms of different factors. More specifically, the study seeks to answer the following questions:

1. What are the levels of RC and MLS-E among pre-service teachers?

2. Do the RC and the MLS-E level among pre-service teachers differ significantly according to the variables of gender, department, and grade?

3. Is there a significant difference in RC and MLS-E levels among pre-service teachers studying in departments of primary school and mathematics teaching?

4. Is there a relationship between RC, reading time and MLS-E levels among pre-service teachers?

5. Which variables predict MLS-E significantly?

METHOD

This is quantitative research in the type of descriptive survey examining the RC and MLS-E levels among pre-service teachers in terms of several variables. In descriptive studies, given situations are attempted to be explained in detail (Fraenkel et al., 2013). In addition, this is correlational research as it examines the relationship between RC, the types of books read, the duration of reading, and MLS-E levels of pre-service teachers. In relational research, correlations between two or more variables are calculated. The existence of a relationship between variables gives a hint about the probable existence of a causal relationship without necessarily indicating it (Büyüköztürk et al., 2014).

Participants

Participants of the study comprises pre-service teachers studying in mathematics and primary school teaching departments from different regions of Türkiye. These pre-service teachers were included in the study because mathematics courses are included in the curriculum of both departments. In addition, pre-service teachers were selected since it was aimed to draw conclusions regarding the current situation in higher education. To reach a sample that will represent the population, pre-service teachers studying at education faculties were selected with the convenient sampling method, one of the purposive sampling techniques. Thus, data were collected from a total of 562 pre-service teachers from 7 different universities.

Of the pre-service teachers participating in the study, 399 (%71.0) were female and 163 (%29.0) were male. 166 (%29.5) of the participants were from İnönü University, 181 (%32.2) from Kırşehir Ahi Evran University, 69 (%12.3) from Afyon Kocatepe University, 67(%11.9) from Karamanoğlu Mehmetbey University, 41 (%7.3) from Alanya Alaaddin Keykubat University, 12 (%2.1) from Selçuk University and 26 (%%4.6) from Aksaray University. 365 (%64.9) of the pre-service teachers are studying in the Primary School Teaching department and 197 (%35.1) in Mathematics Teaching department. 147 (%26.2) pre-service teachers were from the 1st grade, 137 (%24.4) from the 2nd grade, 204 (%36.3) from the 3rd grade and 74 (%13.2) from the 4th grade. The ages of the pre-service teachers vary between 17 and 30, with an average of 20.90 (± 1.56).

Data collection tools

The Reading Culture Scale (RCS) developed by Türkel et al. (2017), the Mathematical Literacy Self-Efficacy Scale (MLSS) developed by Özgen and Bindak (2008) and a personal information form were used when collecting the research data. The RCS consists of 30 items and 4 subscales. The internal consistency coefficient for the overall scale is 0.90. The MLSS is prepared as a 5-point Likert scale consisting of 25 items, 4 of which are negative and 21 of which are positive. The internal consistency coefficient of the scale is 0.94, the lowest score that can be obtained from the scale is 35 and the highest score is 175. The Cronbach α reliability coefficients calculated for the scales and sub-dimensions are presented in Table 1.

Table 1. Reliability coefficients of the scales

Scale		Number of Items	Cronbach's α
MLSS		25	.888
RCS		30	.885
Sub-dimensions of the RCS	Individual Development Reading Relationship	12	.804
	Basic Reading Skill	10	.798
	Visual Reading	4	.587
	Book Selection	4	.725

A reliability coefficient of .700 and above indicates that the reliability of the scale is at an acceptable level (Büyüköztürk, 2014). The reliability levels calculated for MLSS, and RCS are accordingly above the acceptable level. The same goes for the Individual Development Reading Relationship, Basic Reading Skill, and Book Selection sub-dimensions of RCS. However, the value in question is below the acceptable level for the Visual Reading sub-dimension of RCS which is to be considered as a limitation. Therefore, when the results and conclusions regarding Visual Reading were examined, this situation should be taken into account.

The personal information form was used to collect data on the variables of gender, department, grade, age, average number of books they read per month, average number of hours they spend for reading per week, and the type of book they like to read most (literary and scientific genres).

Data collection process

Personal information form, MLSS, and RCS were brought together in line with the purpose of the research. Following the necessary permissions, the data were collected by the advisors of the pre-service teachers at the above-mentioned universities during the 2021-2022 Spring term. Voluntary participation was prioritised in the course of data collection. The collected data were conveyed to the researchers by courier; they were brought together by the researchers. Incomplete, incorrect, or carelessly filled answer forms were not included in the collected data. Out of 752 questionnaires were collected from pre-service teachers only 562 of them were taken since the others were incomplete.

Data analysis

Not only descriptive statistics but also several inferential techniques were used to analyse the research data. First of all, descriptive statistics of frequency, mean, standard deviation, and minimum and maximum variables were employed to examine the levels of MLS-E and RC among pre-service teachers. The term 'level/s' used along the manuscript regarding MLS-E and RC refers to 'score/s' of the students obtained from the scales and subscales. After then, an independent sample *t*-test was used to compare the levels of MLS-E and RC in terms of gender, department, and book types. Grade levels were compared through parametric one-way ANOVA methods. One-way MANOVA was used to determine whether the pre-service teachers' scores of RC and MLS-E were independent of the department they study. The assumptions of these techniques were checked over before starting the analysis. There were no missing or extreme values that could significantly affect the research results. Whether the dependent variable was normally distributed according to the categories of independent variable was checked as well. It was observed that skewness and kurtosis values were in the range of -1 to +1, the mean and 5% trimmed mean values and the mean, median and mode values were very close to each other, histogram graphs were similar to the standard normal distribution, and the data did not significantly deviate from normal in the normal Q-Q plot. As a result, these results indicate that the data do not significantly deviate from normality (Çokluk et al., 2014; Koyuncu, 2016; Tabachnick & Fidell, 2012). The computed and reported *t* statistics and significance values were used when homogeneity of variance was not ensured for the independent sample *t* test.

Homogeneity of variance was also ensured for one-way ANOVA. In the scatter plots examined for one-way MANOVA, the dependent variables showed a low level of correlation for the departments the pre-service teachers study in. Pairwise correlations, tolerance, condition index and VIF values (< 10) showed no singularity or multicollinearity problems. MANOVA results were reported and interpreted on Pillai's Trace values rather than Wilks Lambda, because the Box's M test for homogeneity of variance and covariance matrices was significant ($p<.05$).

Pearson and Spearman correlation coefficients were calculated to examine the relationship between continuous variables and MLS-E. First of all, Spearman's rho correlation coefficient was calculated since the variables of number of books they read per month and duration of reading books per week were not normally distributed. As the other variables showed normal or near-normal distribution, the Pearson correlation coefficient was also calculated for all paired correlations and reported together with Spearman's correlation coefficient.

Finally, a hierarchical multiple linear regression analysis was conducted to determine the predictors of MLS-E. The assumptions for hierarchical multiple linear regression were checked before the analysis was carried out. First, there was a low level of correlation between the dependent variable and each of the independent variables when the scatterplots were examined. Secondly, there were no problems of singularity or multicollinearity according to pairwise correlations, tolerance values, condition indexes, and VIF values (< 10). Thirdly, the P-P plot of normality indicated that residual errors were close to normal distribution. Fourthly, the residual scatter plots showed no homoscedastic distribution. After the assumptions were checked, hierarchical multiple linear regression analyses consisting of two blocks were initiated. The first block of analysis included the RC variable, while the second block included the variables of gender, grade level, department, and preferred book type. Since the variables in the second block were categorical, they were coded as 1 and 0 separately as dummy variables. Microsoft Excel and IBM SPSS package programs were used to prepare the data for analysis.

FINDINGS

Findings regarding the first research problem

Descriptive statistics for RC and MLS-E levels among pre-service teachers are presented in Table 2.

Table 2. Reading culture and mathematical literacy self-efficacy levels among pre-service teachers

Scale		N	Min.	Max.	Mean	Std. Dev.
MLSS		562	46.00	125.00	88.46	12.77
RCS		562	30.00	146.00	99.95	15.57
Sub-dimensions of the RCS	Individual Development Reading Relationship	562	12.00	59.00	40.14	6.97
	Basic Reading Skill	562	10.00	50.00	34.06	6.63
	Visual Reading	562	4.00	20.00	11.77	2.99
	Book Selection	561	4.00	20.00	14.01	3.35

Table 2 shows that pre-service teachers' levels of MLS-E and RC are above the moderate with a mean value of 88.46 (±12.77) and 99.95 (±15.57), respectively. However, the mean value for the relationship between reading and individual development as a sub-dimension of RC is below the moderate with a value of 40.14 (±6.97). The mean values are 34.06 (±6.63) for basic reading skill, 11.77 (±2.99) for visual reading, and 14.01 (±3.35) for book selection, which are close to or slightly above the moderate level.

Findings related to the second research problem

The independent sample *t*-test was used to determine whether pre-service teachers' RC levels differ significantly in terms of their department and gender. The differentiation in terms of grade level was examined through one-way ANOVA. Analysis results are presented in Table 3.

Table 3. Comparison of reading culture scores in terms of variables

Variable	Category	N	Mean	Std. Dev.	t	df	Sig. (2-tailed)
Gender	Female	399	102.25	13.47	4.908*	233.789	.000
	Male	163	94.34	18.69			
Department	Primary School Teaching	365	100.65	15.60	1.441	560	.150
	Mathematics Teaching	197	98.67	15.48			
					F	df	Sig. (2-tailed)
Grade	1st Grade	147	97.64	13.05	1.728	3	.160
	2nd Grade	137	99.83	16.03			
	3rd Grade	204	101.33	16.51			
	4th Grade	74	100.97	16.38			
	Total	562	99.95	15.57			

* Value is significant at the 0.05 level (2-tailed).

Table 3 indicates that there is no statistically significant difference between the mean scores of RC among the pre-service primary school teachers (100.65±15.60) and those of the pre-service mathematics teachers (98.67±15.48) (t=1.441, p=.150). However, the mean score of RC among female pre-service teachers (102.25±13.47) is significantly higher (t=4.908, p=.000) than that of male ones (94.34±18.69). The results of the one-way ANOVA test presented in Table 3 show that the pre-service teachers' scores of RC do not differ significantly according to their grade levels (F=1.728, p=.160).

The independent sample *t*-test was employed to reveal whether the levels of MLS-E among the pre-service teachers differ significantly according to their major, gender, and the type of book they read. Differentiation according to grade levels was examined with one-way ANOVA. Analysis results are presented in Table 4.

Table 4. Comparison of mathematical literacy self-efficacy scores in terms of variables

Variable	Category	N	Mean	Std. Dev.	t	df	Sig. (2-tailed)
Gender	Female	399	87.11	12.32	-3.980*	560	.000
	Male	163	91.77	13.27			
Department	Primary School Teaching	365	86.24	13.24	-6.141*	477.574	.000
	Mathematics Teaching	197	92.57	10.71			
Book Type	Literary	444	87.60	12.54	-3.132*	560	.002
	Scientific	118	91.70	13.12			
					F	df	Sig. (2-tailed)
Grade	1st Grade	147	85.93	11.84	2.814*	3	.039
	2nd Grade	137	89.61	13.05			
	3rd Grade	204	88.92	13.38			
	4th Grade	74	90.08	11.74			
	Total	562	88.46	12.77			

* Value is significant at the 0.05 level (2-tailed).

According to Table 4, MLS-E mean scores of the primary school pre-service teachers (86.24±13.24) are significantly lower (t=-6.141, p=.000) than those of the pre-service mathematics teachers (92.57±10.71). Similarly, MLS-E mean scores of the female pre-service teachers (87.11±12.32) are significantly lower than those of the male pre-service teachers (91.77±13.27) (t=-3.980, p=.000). MLS-E mean scores among the pre-service teachers who read literary books

(87.60±12.54) are significantly lower (t=-3.132, p=.002) than those of the pre-service teachers who read scientific books (91.70±13.12).

As seen in Table 4, the results of the one-way ANOVA test indicate that the pre-service teachers' scores of MLS-E differ significantly in terms of grade levels (F=2.814, p=.039). The results of the LSD multiple comparison test with regard to grade levels show that the average literacy score of the 1st grade pre-service teachers (85.93±11.84) is significantly lower (p<.05) than that of the 2nd grade (89.61±13.05), the 3rd grade (88.92±13.38) and the 4th grade pre-service teachers (90.08±11.74) (p<.05). According to the results of the LSD multiple comparison test, no significant difference exists between the average scores of the other classes (p>.05).

Findings related to the third research problem

A one-way MANOVA was employed to determine the significance of differentiation in levels of RC and MLS-E among the pre-service teachers studying in departments of primary school teaching and mathematics teaching (Table 5).

Table 5. One-way MANOVA results

Scale	Department	Mean	Std. Dev.	N	Tests of Between-Subjects Effects					Multivariate Tests				
					F	df	Error df	Sig.	η^2	F	Hypothesis df	Error df	Sig.	η^2
MLSS	Primary School	86.24	13.24	365	33.27*	1	562	.000	.056	19367.029*	2.00	559.00	.000	.986
	Mathematics	92.57	10.71	197										
RCS	Primary School	100.65	15.60	365	2.076	1	562	.150	.004					
	Mathematics	98.67	15.48	197										

* Value is significant at the 0.001 level (2-tailed).

The results of the between-subjects effects test show that the department in which the pre-service teachers' study has a significant influence on their MLS-E (F [1, 562] = 33.27; p < .0001; partial η2 = .056), whereas it has no significant effect on RC scores (F [1, 562] = 2.076); p < .0001; partial η2 = .004). According to the multivariate test results, pre-service teachers' scores of MLS-E and RC are not independent of the department they study in (F (2, 559) = 19367.029, p < .0001; Pillai's Trace = 0.069, partial η2 = .986). When the scores of RC and MLS-E are taken into consideration together, it is observed that the pre-service teachers' department creates a significant influence on these two variables.

Findings related to the fourth research problem

The Pearson and Spearman correlation coefficient values and their significance levels calculated for the relationship between pre-service teachers' RC, RC sub-dimensions, reading time and MLS-E levels are given in Table 6.

Table 6. Correlation table

			Mathematical Literacy Self-Efficacy	
Variables			Pearson Correlation	Spearman's rho
Reading Culture		r	.207*	.247*
		Sig. (2-tailed)	.000	.000
		N	562	562
Sub-dimensions of the Reading Culture Scale	Individual Development Reading Relationship	r	.155*	.180*
		Sig. (2-tailed)	.000	.000
		N	562	562
	Basic Reading Skill	r	.150*	.177*
		Sig. (2-tailed)	.000	.000
		N	562	562
	Visual Reading	r	.210*	.225*
		Sig. (2-tailed)	.000	.000
		N	562	562
	Book Selection	r	.157*	.177*
		Sig. (2-tailed)	.000	.000
		N	561	561
Average number of books read per month		r	-.022	-.070
		Sig. (2-tailed)	.600	.097
		N	562	562
Average hours spent on reading per week		r	-.026	-.003
		Sig. (2-tailed)	.546	.937
		N	562	562
Age		r	.123*	.117*
		Sig. (2-tailed)	.003	.005
		N	562	562

* Correlation is significant at the 0.01 level (2-tailed).

Table 6 shows a statistically significant and low correlation between RC, RC sub-dimensions, age, and MLS-E levels of pre-service teachers ($p<.05$). There is no statistically significant relationship between average number of books they read per month, average hours spent on reading per week and their MLS-E levels ($p>.05$).

Findings related to the fifth research problem

A hierarchical multiple linear regression analysis consisting of two blocks was conducted to determine the variables and significance levels that predicted pre-service teachers' MLS-E. In the first block of analysis, only the RC variable was added to the model. In the second block, the variables of gender, department, the type of book read and grade level, which were observed to differ significantly in terms of MLS-E scores, were added to the model. Categorical variables were coded as dummy due to the nature of the regression analysis. Analysis results are given in Table 7.

Table 7. Results of hierarchical multiple linear regression analysis

Model[a]	Variables	Model *F*	ΔR^2	*B*	*Std. Error*	*β*	95% Confidence Interval for B	
							Lower Bound	Upper Bound
1	(Constant)	24.995*	.043	71.518*	3.429		64.783	78.253
	Reading Culture			.169*	.034	.207	.103	.236
2	(Constant)	14.995*	.159	75.155*	3.446		68.385	81.924
	Reading Culture			.218*	.033	.266	.153	.283
	Gender (Female)			-5.818*	1.183	-.207	-8.141	-3.495
	Department (Primary School)			-6.438*	1.075	-.241	-8.549	-4.327
	Book Type (Literary)			-1.680	1.284	-.054	-4.203	.842
	Grade (2nd)			1.845	1.418	.062	-.941	4.631
	Grade (3rd)			1.680	1.284	.063	-.843	4.203
	Grade (4th)			.774	1.717	.021	-2.599	4.146

a. Dependent Variable: Mathematical Literacy Self-efficacy

* Value is significant at the 0.001 level (2-tailed).

According to Table 7, the RC variable could explain only 4.3% of the variation in MLS-E. All the variables in the second model explained 15.9% of this variation. The variables added to the second model increased the explained variance rate by 11.6%, causing a significant change in the model F value ($p<.05$). The first model [$F(1, 560) = 24.995$, $p < .001$] and the second model [$F(7, 554) = 14.995$, $p < .001$] considerably fitted the data.

The RC variable in the first model in Table 7 significantly explains MLS-E [$t(559) = 5.00$, $\beta = .207$, $p < .001$]. A 1-unit change in RC score creates a .207-unit change in MLS-E score. In the second model, RC [$t(553) = 6.57$, $\beta = .266$, $p < .001$], gender [$t(553) = -4.92$, $\beta = -.207$, $p < .001$] and department (Primary School Teaching) [$t(553) = -5.991$, $\beta = -.241$, $p < .001$] are significant predictors of mathematical literacy. Accordingly, a 1-unit increase in RC score leads to an increase in MLS-E by .266 units. A 1-unit increase in the variables of gender and department (Primary School Teaching) decreases the MLS-E score by .207 and .241 units, respectively.

DISCUSSION

Paying attention to the factors that shape MLS-E during the education process is expected to help increase the quality of mathematics teaching. RC plays a crucial role in enhancing the quality of MLS-E and serves as a significant predictor of mathematics achievement. Therefore, understanding and interpreting the relationship between RC and MLS-E is essential. The relationship between pre-service teachers' RC and MLS-E was investigated in the present study. In this section, firstly, the results regarding pre-service teachers' RC and MLS-E are presented, and then the results regarding the power of RC to predict MLS-E are discussed.

Reading culture

The pre-service teachers' RC was identified to be above the moderate level, indicating a satisfactory level of engagement with reading activities. However, when delving into the sub-dimensions of RC, disparities were observed. While basic reading skill, visual reading, and book selection sub-dimensions were around or slightly above the moderate level, the reading-individual development relationship sub-dimension scored below the moderate level. This discrepancy suggests that specific areas within RC may require further attention and improvement among pre-service teachers. A moderate level of RC, as highlighted in the study, may not be adequate for pre-service teachers who are expected to serve as exemplary figures for their students. The finding that the pre-service teachers' RC was at moderate and above the intermediate level is like the results of the studies investigating the RC of university students (Maldybaevna et al., 2022) and pre-service teachers (Baki

& Gökçe, 2020). On the contrary, Clark et al. (2015) argue that the effectiveness and success of teachers in shaping student growth and achievement are paramount. They emphasize the significance of well-trained teachers who possess adequate content and pedagogical knowledge, particularly in teaching reading skills. This contrasts with the notion that a moderate level of RC among pre-service teachers may be insufficient, as Clark et al. (2015) suggest that teachers play a crucial role in student development and achievement. Moreover, the concerns raised by Saracaloğlu et al. (2003) regarding the weak infrastructure of RC in Türkiye shed light on broader systemic issues that may impact the cultivation of RC among pre-services teachers. Similarly, the apprehension expressed by Ruterana (2012) about the lack of RC and low literacy levels among university students underscores the urgency of addressing these challenges within the educational landscape. Additionally, the observations made by Kekeeva et al. (2020) regarding the diminishing reading interest and culture due to the rapid influx of information in the digital age and the evolving dynamics that influence reading practices in educational settings globally. In conclusion, while the study underscores the importance of enhancing RC among pre-service teachers, contrasting perspectives highlight the multifaceted nature of factors influencing RC and the complexities involved in evaluating its impact on educational outcomes.

In terms of demographic factors, one of the outstanding results regarding the pre-service teachers' RC is that the average score of RC among female pre-service teachers is significantly higher than that of male pre-service teachers. This trend is supported by research on university students (Maldybaevna et al., 2022), teachers (Azmi, 2013), and pre-service teachers (Altunkaya & Doğar, 2018; Baki & Gökçe, 2020; Kuşdemir et al., 2020; Türkel et al., 2019), indicating a gender disparity in RC favoring women. Studies also suggest that female students generally demonstrate a greater willingness to read and engage in more reading activities than male students (Ajello et al., 2018; Hopper, 2005). According to Manuel and Carter (2015), the differences in the way women and men spend their free time may account for this result. However, it is important to note that some studies have presented contrasting views on gender differences in reading habits. For instance, a study by Torppa et al. (2017) found that gender disparities in reading skills, such as fluency and performance on reading assessments like PISA, may not consistently favour females. Additionally, research (Brozo et al., 2014; Tattersall-Wallin & Nolin, 2020) indicated that while teenage boys may read less than girls, they tend to listen to audiobooks more frequently, potentially narrowing the gender gap in reading habits. These contrasting perspectives suggest that the relationship between gender and reading habits is multifaceted and may vary depending on the specific aspects of reading behaviour being examined (Chettri & Rout, 2013). The pre-service teachers' RC scores did not differ significantly in relation to their departments. Contrary to this finding, some studies (Altunkaya & Doğar 2018; Kuşdemir et al., 2020) found that pre-service teachers' RC differs according to their departments. This discrepancy in findings could be attributed to the diverse cognitive and affective characteristics of pre-service teachers across different departments. Regardless of department, individuals are expected to possess a certain level of RC to actively participate in society, lead a democratic life, achieve academic success, and enhance learning outcomes. As a matter of fact, it is known that individuals with a RC are better at learning (Palani, 2012), and that reading deficiency is associated with low test scores (Brozo et al., 2014; Deale & Lee, 2021).

The pre-service teachers' RC across different grade levels reveals a notable uniformity in scores, with a singular exception of first-year students who manifest significantly lower literacy levels compared to their counterparts in subsequent grades. Our finding that RC does not differ according to the grade variable is in agreement with the findings by Altunkaya and Doğar (2018) and in contradiction with the findings by Baki and Gökçe (2020). The contradiction may stem from the fact that Baki and Gökçe (2020) conducted their study with different department students.This phenomenon suggests a potential increment in RC attributable to the cumulative educational experiences throughout the undergraduate journey. This is to be expected, given that the level of effort required to dramatically alter reading outcomes rises with the age of the individual (Markovitz et al., 2022). However, the literature introduces a multifaceted view on the determinants of RC. Kekeeva et al. (2020) underscore the pervasive influence of digital distractions, delineating a significant barrier to reading engagement among pre-service teachers. Concurrently, Huang (2017) illuminates the adverse impact of external commitments, such as part-time employment and the prevalent use of social media,

on the allocation of time towards academic and extracurricular reading endeavors. Furthermore, Türkel et al. (2019) elucidate the role of individual and environmental factors, suggesting a complex interplay between personal habits, access to reading materials, and the cultivation of a RC, thereby indicating that the enhancement of RC transcends mere academic progression (Kamalova & Koletvinova, 2016) and encompasses broader sociocultural and personal dimensions.

Mathematical literacy self-efficacy

The findings of this study indicate that the pre-service teachers' levels of MLS-E are above average, aligning with previous investigations (Akçay et al., 2022; Zehir & Zehir, 2016), and thereby contributing to the extant literature by reinforcing the notion of generally high MLS-E among pre-service teachers. However, pre-service teachers' levels of MLS-E were found moderate in some research (Önal et al., 2017) and below the average in other research (Arslan & Yavuz, 2012; Ayvaz Can, 2019). Additionally, a recent study (Dağdelen & Yıldız, 2022) revealed that the mathematics literacy self-efficacy of secondary school students is significantly higher than average. These discrepancies suggest that factors such as sample group characteristics, educational background, and achievement levels significantly influence these perceptions, highlighting the necessity for a nuanced exploration of these determinants. Additionally, this study found gender differences in MLS-E, with male pre-service teachers exhibiting higher averages than those of the female pre-service teachers. Concerning the gender-related differentiation in MLS-E, similar results have been reached in several studies (Ayvaz Can, 2019; Schnulz, 2005). Nonetheless, Önal et al. (2017) found that perceptions of MLS-E do not depend on the gender variable. This underscores the complex and content-dependent relationship between gender and MLS-E. This complexity suggests that gender impacts MLS-E in ways that are not straightforward, necessitating a deeper exploration.

MLS-E mean scores of the pre-service mathematics teachers were significantly higher than those of the pre-service primary school teachers. This is an expected result given the course content of the department of mathematics teaching. This difference underlines the impact of specialized coursework on developing domain-specific self-efficacy, reflecting the role educational content plays in shaping pre-service teachers' confidence in their subject matter expertise. MLS-E of pre-service primary school teachers needs to be improved. Altıntaş et al., (2012) likewise concluded that pre-service teachers' MLS-E differs according to departments, aligning with Akçay et al. (2022) who highlighted educational experiences as a key factor. Draper and Siebert (2004) also note a division between mathematics and literacy educators. This division may indicate that the structure of teacher education programs can influence mathematical self-efficacy beliefs, reflecting broader systemic factors at play within the education of future teachers. However, not all studies support this department-based disparity. Contrary to the findings of the present study, Arslan and Yavuz (2012) found that pre-service teachers' MLS-E did not differ significantly across departments. This discrepancy suggests that factors beyond departmental affiliation, possibly including pedagogical approaches or individual experiences, might play a crucial role in shaping MLS-E beliefs, indicating a complex interplay of influences on teacher self-efficacy.

There were significant differences in MLS-E among the pre-service teachers according to the grade level. It was found that the mean MLS-E of the 1st grade pre-service teachers was lower than that of the 2nd, 3rd and 4th grade pre-service teachers. Some studies in the literature similarly found that MLS-E of pre-service teachers depends on the grade level variable. Zehir and Zehir (2016) found that MLS-E levels of the 3rd and 4th grade pre-service teachers were significantly higher than those of the 2nd grade students. In the studies conducted with pre-service primary school teachers, MLS-E of pre-service teachers differed at the grade level. Önal et al. (2017) found a difference in favor of the 4th grade pre-service teachers. Ayvaz Can (2019) found a difference in favor of the 2nd grade students when compared to the 1st graders. Contrary to these results, Altıntaş et al., (2012) found that pre-service teachers could not make progress in MLS-E from the fourth semester until graduation. This pattern of increasing MLS-E with advancing grade levels underscores the cumulative effect of educational experiences on self-efficacy beliefs, suggesting that exposure to and engagement with mathematical content over time builds confidence. MLS-E helps individuals in the data-driven world

of the twenty-first century, numerically based arguments, and data represented in a number of different ways. These skills contribute to the development of the ability to reason, make decisions, solve problems, manage resources, interpret information, plan events, use and apply technology. The emphasis on MLS-E is thus not only a reflection of academic growth but also a crucial component of preparing educators to navigate and impart skills necessary for contemporary challenges (Cheema, 2018). To develop these competencies, students need to be exposed to both mathematical content and real-life contexts (Department of Basic Education [DBE], 2011).

Finally, with regard to the type of book read, MLS-E mean scores of the pre-service teachers who read scientific books were higher than those of the pre-service teachers who read literary books. Mcgeown et al. (2015) state that good readers are more motivated to read and spend more time reading science fiction books, but younger and older individuals with similar reading motivations spend more time on literary texts. Maldybaevna et al. (2022) argue that university students mostly prefer to read literary books. This finding suggests that engagement with scientific literature may be positively associated with MLS-E, potentially due to the analytical thinking and problem-solving skills often required and developed through reading scientific material. These results have important implications for understanding the difference between pre-service teachers with high and low levels of MLS-E and underscore the need for a closer examination of the types of reading materials included in teacher education programs. The correlation between the choice of reading material and MLS-E highlights the broader educational benefit of integrating diverse reading materials, especially those with scientific content, to enhance the pedagogical skills of pre-service teachers.

Relationship between reading culture and mathematical literacy self-efficacy

An examination of the pre-service teachers' scores of MLS-E and RC indicates a dependency on their respective departments. Pre-service mathematics teachers and pre-service primary school teachers are expected to exhibit higher levels of MLS-E and RC. However, a low-level positive correlation was found between the scores of RC, its related sub-dimensions, ages, and levels of MLS-E. This finding aligns with the argument put forth by researchers (Hübner et al., 2022; Mumcu & Aydoğan, 2022) that reading and math skills are closely linked and develop early in life (Erbeli et al., 2021). On the other hand, no significant relationship was discovered between the number of books pre-service teachers read, their reading time, and their MLS-E. Despite the positive relationship between RC and MLS-E, it is noteworthy that qualitative factors such as book type and grade level, as well as quantitative factors such as the number of books and reading time, do not support this relationship. This underscores the importance of focusing on qualitative factors rather than solely on the quantity of books read and the duration of reading. These findings emphasize the multifaceted nature of the factors influencing MLS-E, underlining the need for a comprehensive approach that considers both intrinsic and extrinsic influences.

RC, gender, and department are significant predictors of MLS-E. An increase in RC is associated with higher MLS-E, whereas female students and those studying in the Primary School Teaching department are linked to lower MLS-E. The correlation between these variables and MLS-E was found to be low. These findings coincide with the conclusion by Arofah and Ningsi (2021) that an inclination towards learning mathematics is positively influenced by an increase in reading interest and study habits. Additionally, Reinke et al., (1997) and Sullivan and Brown (2015) state that reading skills play a crucial role in achieving success in mathematics, and that children's reading behaviour is closely tied to their mathematics test scores. Therefore, the responsibility of fostering a robust RC in schools rests on teachers who have the authority to cultivate such an environment (Aramide, 2023).

Implications for teacher development and limitations

This study can provide some information for teacher development and future studies in the context of RC and MLS-E components. As a matter of fact, teachers with a RC play an important role in students' acquisition of reading habits and culture by preparing an environment suitable for this culture in their classrooms. The low RC among pre-service teachers, who are the teachers of the

future, will also reflect on the RC of future students. Bilavych and Rozman (2016) state that there is an urgent need to create a RC for students at the university, and that the RC level of students can be improved if an organized teacher education system is implemented. For this reason, it is important to make changes in the undergraduate curriculum and to organize activities that will boost RC among pre-service teachers. To effectively implement these changes, teacher education programs could include workshops, book clubs, and collaborative reading projects that specifically align with mathematical literacy goals. Incorporating digital resources, such as e-books and educational apps, into these activities could address diverse learning preferences and foster a more inclusive reading environment (Ajayi et al., 2014). Since libraries have a great role in the creation of RC, university libraries should be equipped with rich content so that pre-service teachers can easily access publications other than textbooks. Expanding the library's digital collection to include subscriptions to academic journals, online databases, and multimedia resources related to both reading and mathematics can enhance the accessibility and appeal of library resources.

With the expanded guidance services in universities, activities can be organized to increase pre-service teachers' RC and MLS-E levels, which were found above the moderate level in the present study. As a result of the present study, it is found that RC is one of the significant predictors of MLS-E. Primary school pre-service teachers also have mathematics lessons in their teaching life. To further support the development of MLS-E, integrating real-life problem-solving activities into the curriculum and offering specialized workshops that focus on practical applications of mathematical concepts in everyday situations could be beneficial (Özçakır-Sümen & Çalışır, 2016). Activities can be organized to improve MLS-E among pre-service primary school teachers, and elective mathematics lessons related to daily life situations can be added to the curriculum.

This research has some limitations which may guide future studies. The data of this research is relational in nature. It restricts the establishment of a causal link between pre-service teachers' RC and MLS-E. These limitations suggest caution when generalizing the findings beyond the study sample. Future research could explore these relationships through experimental designs to establish causality more definitively. Large survey or longitudinal studies can be conducted to determine the factors affecting RC and MLS-E among pre-service teachers by considering such distinct variables as age, gender and achievement from primary school to university. Secondly, the variable of RC was found to have explained only a small part of the variation in MLS-E. Although data are collected from samples in different geographical regions, this result is mostly obtained from data collected from university students who are considered to be up-country universities. This may limit generalizability. To overcome this limitation, future research could include a broader demographic, encompassing students from various educational backgrounds and regions, including both rural and urban settings. In addition, observation, interview and experimental methods can be used to determine why this small variation in MLS-E exists or if there is a way to increase that variation. These methods could provide deeper insights into the personal and environmental factors influencing RC and MLS-E, offering a richer understanding of how to effectively enhance these important educational outcomes. Interdisciplinary research can be carried out to provide an in-depth understanding of RC and MLS-E.

CONCLUSION

During the education process, it is desirable to maximize students' qualifications of knowledge, skills, and competencies in line with individual characteristics. For this purpose, to ensure that students from all walks of life have access to well-equipped teachers to help them learn is central to the field of teacher education (Bardelli et al., 2023). Mathematical literacy is as important as reading and writing proficiency. Since mathematics is intertwined with today's lifestyle, it is not possible to fully grasp the information surrounding us without understanding the basic mathematical ideas. In this context, the concept of literacy is related to the field of mathematics, and mathematical literacy is closely related to literacy (İlhan et al., 2019).

In conclusion, the pre-service teachers' RC and MLS-E were found above the moderate level. In addition, MLS-E mean scores of the primary school pre-service teachers were significantly lower

than those of the mathematics pre-service teachers; MLS-E mean scores of the female pre-service teachers were significantly lower than those of the male pre-service teachers; MLS-E mean scores of the pre-service teachers who read literary genres were significantly lower than those of the pre-service teachers who read scientific genres. Gender (femaleness) and department (Primary School Teaching) were found to be significant predictors of mathematical literacy.

The implications of these findings have significant implications for teacher education. They emphasize the importance of targeted interventions in teacher preparation programs to improve RC and MLS-E. These efforts are crucial in equipping future educators to create an inclusive learning environment that supports the mathematical and literacy skills of all students.

Acknowledging the limitations of this study, particularly its focus on relationships, indicates the need for further research. Future investigations that use longitudinal designs and experimental methodologies can provide deeper insights into the causal connections between RC, MLS-E, and educational outcomes. Moreover, expanding the demographic range of participants can enhance the applicability of these findings and contribute to a more comprehensive understanding of the factors that affect teacher preparedness and student achievement in mathematics.

Based on these findings, we urge educators, policymakers, and researchers to acknowledge the critical role of RC and MLS-E in teacher education. By addressing these key areas, we can take significant strides towards preparing a new generation of teachers who are equipped to meet the challenges of educating students in the 21st century. The ultimate aim is to guarantee that every student, irrespective of their background or personal traits, can obtain excellent education that enables them to navigate and excel in a progressively complex and mathematically-focused global setting.

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