IOJPE
ISSN: 1300 – 915X
www.iojpe.org
International Online Journal of Primary Education 2023, volume 12, issue 2

MODELING OF READING PROBLEMS EXPERIENCED BY PRIMARY SCHOOL STUDENTS THROUGH ARTIFICIAL NEURAL NETWORKS

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Received: May 17, 2022 **Accepted:** March 01, 2023 **Published:** June 30, 2023

Suggested Citation:
Çelik, C., & Kartal, H. (2023). Modeling of reading problems experienced by primary school students through artificial neural networks. *International Online Journal of Primary Education (IOJPE), 12*(2), 94-117. https://doi.org/10.55020/iojpe.1117626

Abstract

The aim of this study is to investigate the causes of reading problems experienced by third-grade students because of the instructional malpractices in education and develop a modeling with artificial neural networks. It was carried out according to the exploratory sequential model and consisted of two stages. In the qualitative part, a data pool with 35 items is created for the shortcomings caused by educational practices that underlie the reading problems experienced by the students through the opinions of 47 classroom teachers participating in this study. The second part is where the checklist designed based on the data obtained in the first part is administered to 174 classroom teachers who lecture the third graders. The numerical values are processed into MATLAB, and two different models, forecast and classification models, are developed for the shortcomings caused by educational practices that underlie the reading problems experienced by the students through artificial neural networks. In this regard, this study intends to identify solutions to the potential reading problems that students may experience due to the shortcomings caused by educational practices before they arise, and to develop preventive actions.

Keywords: Reading, reading difficulty, artificial neural networks, education and training.

INTRODUCTION

Reading, one of the most effective ways of learning (Adalı, 1990; Bamberger, 1990; Devana & Agustiani, 2019; Richardson, Morgan, & Fleener, 2012) is a key skill to cope with the abundance of information in this rapidly changing and developing technology world and to obtain the correct information (Sangkaeo, 1999). That said, students need to be able to benefit from the information they learn by reading, and thus, reading skills still remain important today (Organisation for Economic Co-operation and Development, 2000). Good reading skills contribute to academic achievement for students, as well as significantly help them when they become adults in today's societies which are based on knowledge (Eurydice, 2011).

Reading, which enjoys the interaction of psychological, sociological, economic, cultural, and educational factors, is considered as a complex activity, making a single definition of reading elusive to make (Özbay, 2006). Therefore, a whole number of different definitions of reading are available. Some of them are as follows:

Reading, a magical process (Akyol, 2016), is performed through the means of the eye and for the purpose of brain activity (Ruşen, 1999). A mental and intellectual activity (Özdemir, 2011), reading is one of the most effective ways to improve language skills and personality (Bamberger, 1990).

Reading is an activity that enhances the intellectual world of an individual, contributes to the accumulation of knowledge, helps developing an aesthetic point of view, and also creates a source of happiness for an individual (Tural, 1992). Not merely about seeing words or sentences, reading entails certain mental activities beyond seeing so that understanding can be achieved (Dökmen, 1994). From this standpoint, reading is a complex activity that involves the eye seeing, recognizing the writing and the mind trying to understand it; and it also includes mental, affective, and dynamic processes (Nas, 2003). But knowledge of characters and reading technics alone are not sufficient to develop real reading societies (Sangkaeo, 1999). Noting that every reader is a literate, but not every literate can be a reader, Özdemir (2004) emphasizes the aspect of reading that differs from literacy and its importance.

Students improve their reading skills acquired in school over time and as they grow through the grades. As reading skills improve and are more and more needed to learn the curriculum, reading, which is the means of obtaining knowledge, gains a new significance for students (Duke & Carlisle, 2011). After the first years in which basic reading is taught and skills are gained, students move from the stage of learning to read to the stage of "reading to learn" (Eurydice, 2011). Possible gaps and delays in reading skills increase in the following school years and the subsequent learning process (Chall et al., 1990). Although reading instruction is significant for academic achievement and school learning, its importance also lies in social life. In this sense, Dwyer (cited from Chiariello, 2018) considers reading skill as the difference between being included in social life and being excluded from society.

Problems in reading skills are a learning disability that affects not only the academic success of students in the school environment (Hakkarainen, Holopainen & Savolainen, 2013; Norbury, Gooch, Baird, Charman, Simonoff, & Pickles, 2016; Smart, Youssef, Sanson, Prior, Toumbourou, & Olsson, 2017; Suggate, Schaughency, & Reese, 2013) but also their social life and future life (Çayır & Balcı, 2017; Türkmenoğlu & Baştuğ, 2017) and necessitate early intervention (Çayır & Balcı, 2017). Waiting for such problems in reading to resolve themselves will lead to even greater problems (Chall et al., 1990). It is considered as highly unlikely that the lagging children in literacy and language skills that can be developed throughout life will overcome these deficiencies without getting any special help (Chall et al., 1990). That said, if prevention work is not undertaken regarding the cause of reading difficulties experienced by students, these difficulties continue to be present over time will reduce the effectiveness of future prevention efforts.

It is a national and priority goal in the United States to ensure that all students fully acquire reading skills by the end of the 3rd grade (Wonder-Mcdowell, Ray Reutzel, & Smith, 2011). In this regard, the first three grades after the student has learned reading are considered as critical; during these grades, reading instruction is important. Indeed, it is assumed that children in the fourth grade have completed the stage of learning to read and moved into the stage of reading to learn (Dickinson & McCabe, 2001; Snow, Burns, & Griffin, 1998; Spangler, 2016; Spear-Swerling, 2006). Children who learn to read in this process will progress step by step in order to become fluent readers in a short time with the reading environments and experiences to be presented to them. On the contrary, children who have not fully acquired their reading skills will have problems in reading; when a preventive or intervening approach is not taken to these problems, reading problems will continue to increase in the following academic years.

Difficulties experienced by an individual while reading due to lack of any of the reading skills such as correct recognition and analysis of written codes, fluent reading, reading comprehension, adequate vocabulary are defined as reading difficulties (Özsoy, 1984). The Diagnostic and Statistical Manual of Mental Disorders published by the American Psychiatric Association (2013) considers reading disability as a type of Specific Learning Disability and defines it as problems in word reading accuracy, reading speed, reading fluency, and reading comprehension skills, although the individual has a level of intelligence required by his/her chronological age. Reading difficulties, the main reason of academic incompetence, are a learning problem often experienced by students (Ergül, 2012).

Problems in reading encountered by children are the most common reason why they are diagnosed with learning disabilities (Denton, Montroy, Zucker, & Cannon, 2021; Fletcher, Lyon, Fuchs, & Barnes, 2018; Snowling, & Hulme, 2012; Stanford & Oakland, 2000).

Foremost among the reasons for such problems experienced by children with reading difficulties are facilities at home, previous school experiences, sensory deficiencies, and low levels of intelligence (Dolch, 1940). Vellutino, Fletcher, Snowling and Scanlon (2004) suggest strong evidence that most of the reading difficulties that arise in the early years are caused not by cognitive deficiencies, but by a lack of experiential and didactic approaches. It is reported that the problems of children who have reading problems in the first years of their education continue in the following years as well (Bruck, 1992; Dickinson & McCabe, 2001; Nation, 2019).

It is of paramount importance to recognize the reading difficulties experienced by students as early as possible, to intervene and minimize these problems so that they cannot lead to greater problems (Dowdall, Melendez-Torres, Murray, Gardner, Hartford, & Cooper, 2020; Flowers et al., 2001; Gersten, Haymond, Newman-Gonchar, Dimino, & Jayanthi, 2020; Kuhn & Stahl, 2003; Schwanenflugel et al., 2006; Torgesen, 2002). Further, several researchers report that the third grade is of a critical importance in this regard (Hebbecker, Förster, & Souvignier, 2019; Iii, Simmons, & Kame, 2001; Jenkins, Fuchs, Van den Broek, Espin, & Deno, 2003; Peng, Fuchs, Fuchs, Elleman, Kearns, Gilbert, … & Patton III, 2019). Thus, identifying possible reading problems that may occur at an early stage and allocating resources for prevention efforts are critical (Lovett, Frijters, Wolf, Steinbach, Sevcik, & Morris, 2017; Torgesen, 2002; Zijlstra, Van Bergen, Regtvoort, De Jong, & Van Der Leij, 2021); in this regard, schools, families, and policy makers have key responsibilities (Chall et al., 1990).

Research show that although they have no identified or diagnosed deficiencies, some of the students have difficulties in learning reading (Bryant, Bryant, & Smith, 2016). Similarly, Tunmer (2008) evaluates the difficulties experienced by readers in two categories as reading difficulties caused by dyslexia and reading difficulties not linked to dyslexia.

Accordingly, it is required to implement the necessary intervention programs for students with reading problems who have learning difficulties or have been specifically identified as having reading difficulties. However, regarding the identification of reading difficulties, there are students who are not or cannot be included in this group, which remains as an important problem. Thus, reaching out to each child with such difficulties should be one of the priorities of both the education system and teachers. Therefore, it is important to identify the reading problems experienced by students and caused by non-cognitive reasons.

There has been no study in the Turkish literature that thoroughly investigates the non-cognitive causes of reading problems experienced by students. Moreover, no research carried out especially in the field of educational sciences and involving primary schools, has studied artificial intelligence applications. In the relevant literature, there are studies on primary school students who have not been identified as having reading difficulties but experience problems in reading. However, many of such studies (Akar, 2017; Akyol & Ketenoğlu Kayabaşı, 2018; Akyol & Kodan, 2016; Çeliktürk Sezgin & Akyol, 2015; Dağ, 2010; Özkara, 2010; Şahin & Kardaş İşler, 2016; Türkmenoğlu & Baştuğ, 2017; Uzunkol, 2013; Yüksel, 2010) are performed with a small sample of students (all of them, except for one study, are carried out with one student) and offer individual support practices aimed at eliminating reading difficulties. Some research highlight the individual competencies (incompetencies) of the students and some of their characteristics of their families while addressing the reading problems. Nevertheless, they fail to adequately emphasize the school where students spend most of their time as well as educational practices as the causes of reading problems.

It is reported that progress has been made towards the elimination/reduction of reading difficulties through individual support practices. Yet, reaching all students who have problems in reading even though they have not been identified so, will bring along some difficulties. The need for an instructor,

the need for a place to perform the implementation, and scheduling problems are just some of them. Knowing the possible problems that students may have or will experience and the causes of these problems in advance as well as developing preventive practices to eliminate the causes of the reading problems before they arise, are of paramount importance to produce solutions to the reading problems before they occur. In this regard, schools and educational practices are valuable. Reading problems directly affect reading success. The aim of this study is to investigate the causes of reading problems experienced by third-grade students because of the instructional malpractices in education and develop a modeling with artificial neural networks.

METHOD

Although there are quite a large number of patterns of the mixed method, Creswell and Plano Clark (2018) distinguishes six designs: convergent parallel, explanatory sequential, exploratory sequential, embedded, transformative and multiphase pattern. This study benefits from exploratory sequential design, one of the mixed method designs. This method assumes that all events and phenomena have both qualitative and quantitative dimensions, and it is necessary to examine both dimensions to make sense of these events and phenomena through a holistic, rich approach (Yıldırım & Şimşek, 2016). The mixed method design includes both approaches in a single study and aims to minimize the weaknesses of both approaches (Johnson & Onwuegbuzie, 2004).

The exploratory sequential design prioritizes the qualitative dimension of research and then moves into the quantitative part after the data are collected and analyzed in the qualitative part, making this design a two-stage sequential mixed method (Creswell & PlanoClark, 2018). Thus, the qualitative method has been applied at the first part of this research. After the analysis of the data obtained through this first part, the quantitative part of the research has been constructed.

Participants

In the qualitative and quantitative stages of the research, different participants were studied.

Sampling for the Qualitative Part

In the qualitative part of this study, which uses purposeful sampling method for data collection, teachers who lecture students with problems in reading and understanding what they are reading in their classrooms are included in the sampling. Further, this study follows two main criteria for the sampling of the teachers: 1) Having a student who participated in the REPPS (Remedial Education Program in Primary Schools) for the Turkish language course in the 2018-2019 or 2019-2020 academic years and 2) Having at least one student who participated in the REPPS in the classroom. Thus, a total of 43 primary schools in eight different districts, two of which are central districts in the city of Eskisehir, Turkey were determined, and a survey form was provided to 37 volunteer classroom teachers meeting the stated criteria in 32 different schools. Also, data were collected from another 10 teachers through face-to-face interviews. That is, the participants who were interviewed are different from the teachers who filled the survey form. The number of participants was contingent upon the amount of the data collected and the saturation point of the sampling. The saturation point is reached when the researcher decides that s/he has obtained sufficient data as the data and concepts seem to become repetitive (Yıldırım & Şimşek, 2016).

Sampling for the Quantitative Part

The quantitative data are collected through the non-selective sampling method, one of the probability-based sampling methods. The teachers who lecture the third-grades in public schools in Eskisehir participated in the quantitative part of this research. According to the statics of the Turkish Ministry of Education for formal education in the 2017-2018 academic year, the number of branch teachers to lecture the third-grades in Eskisehir in the 2019-2020 academic year is estimated to be 480 (Ministry of National Education, 2018). In the determination of the sampling size, the criteria proposed by Yazıcıoğlu and Erdoğan (2014) were followed so that the sampling could represent the population. They argue that a sampling size of 165 is sufficient for a population size of 500; this study has been performed with 174 teachers.

Data Collection Tools
Different data collection tools were used in the qualitative and quantitative stages of the research.

Data Collection Tools in the Qualitative Part
A survey with open-ended questions is used as the data collection tool in the qualitative part of this study. Akalın (2018) divides the questionnaire into two different categories. These are the survey form completed by the participants using only paper and pencil and the interview conducted by the researcher to obtain the information from the participants. Accordingly, the data in the qualitative part of this research were collected through a survey with open-ended questions and face-to-face interviews where the same questions were directed to a different group of participants.

The qualitative part intended to answer the following question: "What are the instructional malpractices in education which caused the basis of the reading problems?"

Data Collection Tools in the Quantitative Part
In the qualitative part, a survey form and a new checklist were designed by analyzing the data obtained from the interviews and these were intended for use in the quantitative part. In general, terms, a checklist is a list that ranks performance indicators (Russell & Airasian, 2011). That said, a 35-item checklist was formed to identify the shortcomings caused by educational practices that underlie the problems that students experience in reading.

In the quantitative part, the teachers were told to "Mark the errors caused by educational practices that underlie the problems that students experience in reading." Moreover, they were asked to mark the items they suppose appropriate (by themselves) in the checklist of 35 items.

Implementation
In order to collect the data, a research permit was granted by the Governor's Office of Eskisehir upon the request of the Rectorate of University. In the qualitative part, the open-ended question of "What are the shortcomings caused by educational practices that underlie the problems that students experience in reading?", which was designed by the researcher, was directed to the teachers (n= 37) and their written responses were obtained. Then, the same question was directed to the teachers who did not fill the survey form (n= 10) and the answers of the teachers were recorded in the interview form. The data collected in this part were analyzed through qualitative analysis methods and a new checklist was formed for use in the quantitative part.

The checklist with 35 items was applied to the classroom teachers (n= 174) lecturing the third-graders in the quantitative part. The data were coded as "1" (representing the teachers who agreed with the items specified in the checklist) or as "0" (representing the teachers who did not agree with the items of the checklist), and then transferred to the artificial intelligence application MATLAB for modelling with artificial neural networks.

Data Analysis
Qualitative Data Analysis
The answers given to the questionnaire and the data obtained from the in-depth face-to-face interviews were made with content analysis and descriptive analysis methods (Yıldırım & Şimşek, 2016), which are data analysis methods used in qualitative research. In the next step, "description", "analysis" and "interpretation" steps were put into practice in data analysis. The answers were given to the survey questions were examined, each question was evaluated and analyzed independently of each other. Responses to open-ended questions were coded, and themes related to the question were created (Ali Balcı, 2016). The answers given by the participants (n=10) in the in-depth face-to-face interviews were analyzed by descriptive analysis method. Responses were coded and conceptualized. The items determined by this analysis were added to the data obtained from the questionnaire. With the analysis of the answers, 35 items were created for the errors caused by the education-teaching practices at the source of the students' reading problems.

Qualitative data were analyzed in categories and the created items were reported. It was presented to the three interviewees for participant confirmation. Participants did not give any negative feedback about the items. Next step a checklist was prepared with 35 items in order to use it in the quantitative phase of the research.

Quantitative Data Analysis

In the quantitative dimension of the research, the data gathered with the prepared checklist were coded and then transferred to the excel program. The data are coded as "1" and "0". The items marked by the teachers were coded as "1" and the items not marked as "0". The coded data was transferred to the MATLAB program and a separate modeling was developed for each category with artificial neural networks.

Data Analysis for the Forecasting Model. In MATLAB application, all data should be converted to numeric values and normalized. First, the data was transferred to the Excel program. The items that the teachers stated and chose as a problem were indicated with a value of "1", and the items that they did not consider as a problem were indicated with a value of "0". These data were processed as input values to the MATLAB application.

Difficulty values were calculated for each of the problems coded as "1" and "0". These values were obtained by calculating the ratio of teachers who preferred the specified items to the total number of teachers. For example, the difficulty value created for an item marked by 66 participants was calculated by dividing 66 by 174.

A Classifying Model for Data Analysis. In order to create the classifying model, the total difficulty values stated by the teachers were categorized in two different levels as "high" and "low". High and low difficulty levels were calculated with the following formula: The difference between the highest total difficulty level stated by the teachers and the lowest total difficulty level was divided into two. For example, the highest value among the total difficulty values determined is .644, while the lowest value is .046. The number .299, obtained by dividing .598, which is calculated as the difference of two numbers, by two, represents the limit between high-level and low-level difficulty values. In this context, in the classification architecture to be organized for students' reading problems, total difficulty values higher than .299 mean high level difficulties, while total difficulty values lower than .299 mean low level difficulties. represents.

RESULTS

This section presents results on the analysis of data obtained from the opinions of the teachers on the shortcomings caused by educational practices that underlie the problems that students experience in reading.

Qualitative Findings

In this stage of the study, the teachers were asked the following question: "What are the shortcomings caused by educational practices that underlie the problems that students experience in reading?" Table 1 offers the findings on the shortcomings caused by educational practices that underlie the problems that students experience in reading by theme and item. The teachers interviewed under this study are coded with the letter "I" code, and they were referred to as "I1, I2, I3..." For the teachers who participated in and contributed to this study, the letter "P" was used, and they were referred to as "P1, P2, P3..."

Based on the answers of the teachers, this study identified six themes on the shortcomings caused by educational practices that underlie the problems that students experience in reading. These themes are "Teaching Program-Curriculum", "Legislation", "School", "Teacher", "Classroom" and "Textbook." Table 1 shows that a total of 35 items are identified based on these themes. The opinions expressed by the teachers in the education system and their contribution to eliminate these shortcomings may be an advantage.

Table 1. Distribution of the shortcomings caused by educational practices that underlie the reading problems experienced by the students

Teaching Program - Curriculum	**Codes**	
The design of the curriculum failing to recognize individual differences	P1, P9, P11, P14, P30, P35	I2, I7
Not allocating enough time for extracurricular reading	P22	I1, I4, I9
Lack of consensus on writing method	P3	
The mandatory implementation of only a single method in reading instruction	P7, P24, P37	I7
Efforts to keep up with the curriculum and achievements		I1, I3, I5
Activities outside the teaching program	P13	
Changes in primary literacy instruction	P21	I2
Italic-cursive writing application	P23	
Lack of regional curriculum applications	P28	
Achievements in the Turkish language course being mostly grammatically focused	P22	
Legislation		
No chance of repeating the grade	P1, P2, P6, P37	
Early school starting age	P3, P10, P29	I2
Multi-grade classroom teaching practices	P9	I8
Changes in teaching staff (timed/untimely)		I4
Lack of a mechanism to monitor reading progress		I6
School		
Poor physical infrastructure of schools	P30	I3, I7, I8, I10
Lack of technology and materials	P19	I3, I5, I6
Lack of practices that encourage reading	P22	I7
Lack of library	P26	I7
Reading activities not being valued at the school level	P32	I8
Failure to provide encouraging reading environments		I5
Lack of up-to-date and qualified books in school libraries		I1
Teacher		
Teachers' lack of professional competence	P9, P22, P30	I2, I5, I10
Teachers' failure to adequately support students with reading problems	P33, P37	I2, I3
Teachers' preference for books or reading materials that are not appropriate for the grade level	P34	I4, I9
Attaching great emphasis and importance to evaluation in the form of tests	P17, P18, P23	
Competitive approach towards reading instruction among teachers	P20	I10
Teachers with no reading habits	P32	I8
Hasty approach to reading instruction	P13	
Exam-oriented teaching	P23	
Teachers' lack of interest in reading	P13	
Classroom		
Crowded classrooms	P13, P29, P37	I8, I10
In-class competition/competitive climate	P13	
Textbook		
Texts in the textbooks too advanced for students	P22	I1, I9, I10
Uniformity of textbooks	P23	I6

However, this may also imply that the Turkish Ministry of National Education fails to ask the opinions of teachers or consider the solutions proposed by them in order to eliminate these shortcomings. Indeed, one of the teachers interviewed gave a wry smile and shook his/her head, pointing to the voice recorder, after s/he was asked this question, which also supports this assumption. The body language and attitudes of this teacher asked this question may simply indicate that s/he has something to say about this, but chooses not to for some other reasons. Although this teacher expressed his/her thoughts on the question, it is plausible to argue that s/he also had a lot more to say but was unable to.

One of the teachers participating in this study commented on the curriculum: "*We are constantly remarking on the curriculum, but nothing has changed. I mean, the curriculum is very dense, seems very dense to me. In elementary school, they just need to learn reading, writing, four modes of operation that will support them in their daily life. We offer them so much information, but it seems that it is in vain. That is, all these information are too abstract for them."* (P7). It can be thus claimed that the authorities fail to take into account the opinions expressed by teachers.

A teacher who believed that the association of reading with the Turkish language course is one of the shortcomings stated that: "*We should not perform reading activities only during the Turkish language courses. I mean, in my opinion, this is a problem related to instruction. As a matter of fact, reading is not linked to the Turkish language course. I think reading hours or reading sessions must be held. If these problems are resolved, the shortcomings in reading comprehension will be hopefully eliminated too.*" (I1) and emphasized that more reading activities should be performed outside the course.

A teacher who thinks that early school starting age is one of the shortcomings caused by educational practices, stated that: "*You know, the school starting age is reduced; due to the relevant legislation, some children have been granted to start school earlier and children of kindergarten age have been given the right to start school. And the parents rush to send their children to school. I think that if the school starting age is decided after consulting with a teacher and evaluating the child's readiness, this would allow better testing slow reading among today's children and their verbal and mathematical readiness for courses; we could improve children's level of education further.*" (P2).

Mentioning the mandatory use of only a single method for reading instruction, (P7) said that: "*The use of a single method in reading instruction, the overlooking of other methods prevents us benefiting from the positive aspects of the known methods.*" and thus clearly believed that this may cause reading problems. Another teacher emphasized the weaknesses of the sound-based sentence approach, which is the only and mandatory method applied in the literacy instruction in Turkey: "*In general, reading comprehension is a problem related to education provided in our country. I see this problem as a disadvantage of the sound-based sentence method, which is applied to help students become literate. Some students have difficulty in learning from part to whole and when they do not make enough effort for reading comprehension, they experience problems in understanding the whole."* (P24).

One of the teachers, highlighting the shortcomings of the curriculum designed for the entire country and implemented mandatorily, argued that the curriculum should be designed on a regional and local basis, in accordance with the sociocultural structure of the region and individual differences: "*The teaching program is being tested on a certain population and fails to support and to meet the need in the whole country region by region, province by province and district by district. Educational practices are not designed to meet the needs and desires of children, and these practices are developed and implemented based on the general situation.*" (P22).

Asserting that the reading progress of students should be supervised through an administrative mechanism that covers the school administrations and the higher authority levels, a teacher expressed: "*Reading habits among children are developed already through projects. Generally, schools carry out these projects. But for example, under a larger roof, the National Education Directorates fail to carry out such projects and supervise all schools properly; so, they fail to supervise the reading progress of children, as well as their development. So mostly, such supervision is performed by teachers. Only school principals or other higher-ranked staff in schools do not involved in this supervision process; the reading progress of children is not monitored. That is why it is like that there is not much of a supervisory mechanism for students in education.*" (I6). The same teacher noted the lack of reading materials in schools, except for textbooks, especially for students who have difficulties with reading: "*For example, regarding the availability of the materials, educational materials, I mean... For example, some other materials other than the materials we use in classrooms may be designed. I mean, different materials, reading materials, may be developed for children who have difficulty in reading and writing. These materials may then submitted to schools. Because not every*

child can learn using only a printed material, a textbook. Some of them need different visual and auditory stimuli. Such materials may be designed. There are the problems present in the educational environment." (I6)

Drawing attention to physical conditions and financial shortcomings of schools, a teacher stated that: "*The buildings are inadequate; we need more buildings and lack a chess room as well. My kid's going to a private school. It has a marbles field, a climbing wall, a painting workshop, and a music room. What does my kid have that these children do not? S/he is just financially lacking. I feel sad when I witness such cases.*" (I7) and expressed regret that this may lead to inequalities of opportunity in education.

Yet another teacher mentioned the quality and up-to-dateness of books, which are extracurricular reading materials, in school libraries and articulated that: "*School libraries should be equipped with advanced books with a novel perspective. With the books dating back to 1995-2000, we cannot teach children the love of reading and the habit of reading. We need to transform our libraries.*" (I1) and emphasized that if the quality of books in school libraries is not improved and contemporary books are not offered to children, some problems may be experienced in developing the reading habit and the love of reading among children.

Another concern was about the types of the books teachers prefer in reading instruction: "*The greatest mistake is that teachers feel the obligation to perform their reading instruction using educational books and thus prevent children from reading funny books.*" (P34), who expressed that teachers should be competent in choosing quality children's books. Another teacher self-critically remarked on the importance of teachers' attitudes towards reading and being role models in this regard: "*Most teachers don't take the time to read books because they are just worried about their income and to make ends meet or merely out of laziness, like me. It is not sincere for a teacher who does not read books to encourage children to read books, and children can spot insincerity from a mile away. Further, activities such as reading sessions in schools are either not carried out at all, or when they are performed, randomly selected and unreviewed books are used just to pass the time.*" (P32) and thus clearly believed that the reading activities carried out in schools and the quality of the books preferred in these activities are not sufficient.

Quantitative Findings

This section presents findings on the modeling with Artificial Neural Networks (ANN). Overall, two different models were developed for each title created for research purposes, forecast and classification. These models were created through the MATLAB software. In this regard, the findings on forecast modeling are presented first and the findings on classification modeling are offered later on.

Forecast Modeling

The ANN model, which consists of 3 layers: input, hidden and output layers, was trained using the "LecenbergMarquard" (trainlm) optimization algorithm. After the hidden layer, "Hyperbolictangent sigmoid" (tansig) was used as the activation function. The number of neurons used in the hidden layer was 5 in all forecast models. The default training parameters were utilized for the entire ANN architecture created. The stopping criterion is satisfied when the performance of the control set carries out at least 6 cycles. 70% of the data set was used as a train set; 15% was as a validation set and the remaining 15% was as a test set. These data were randomly selected by the system during each training. MSE (Min-squarederror) was the performance indicator based in the evaluation of the models. The findings of the forecast models created by the regression analysis method are presented under the following headings.

Forecast modeling of the shortcomings caused by educational practices that underlie the reading problems experienced by the students. Table 2 demonstrates the difficulty values of the items designed based on the answers given by the teachers. The most common three answers of the teachers

are, respectively, as follows: “Not allocating enough time for extracurricular reading”, “Efforts to keep up with the curriculum and achievements” and “Crowded classrooms.”

Table 2. Difficulty levels of the shortcomings caused by educational practices that underlie the reading problems experienced by the students

Shortcomings Caused by Educational Practices	Difficulty Values of Items
Not allocating enough time for extracurricular reading	.644
Efforts to keep up with the curriculum and achievements	.598
Crowded classrooms	.471
The design of the curriculum failing to recognize individual differences	.466
Texts in the textbooks too advanced for students	.431
Failure to provide encouraging reading environments	.420
Attaching great emphasis and importance to evaluation in the form of tests	.420
Exam-oriented teaching	.391
Lack of practices that encourage reading	.374
Hasty approach to reading instruction	.345
No chance of repeating the grade	.339
Early school starting age	.328
Competitive approach towards reading instruction among teachers	.287
The mandatory implementation of only a single method in reading instruction	.282
Teachers with no reading habits	.270
Changes in teaching staff (timed/untimely)	.259
Teachers' failure to adequately support students with reading problems	.253
Lack of technology and materials in schools	.236
Lack of library	.230
Poor physical infrastructure of schools	.224
Uniformity of textbooks	.207
Lack of up-to-date and qualified books in school libraries	.195
Changes in primary literacy instruction	.184
Lack of regional curriculum applications	.184
Reading activities not being valued at the school level	.184
Lack of a mechanism to monitor reading progress	.178
Teachers' preference for books or reading materials that are not appropriate for the grade level	.155
Teachers' lack of interest in reading	.149
In-class competition/competitive climate	.144
Italic-cursive writing application	.132
Achievements in the Turkish language course being mostly grammatically focused	.126
Teachers' lack of professional competence	.126
Multi-grade classroom teaching practices	.109
Lack of consensus on writing method	.103
Activities outside the teaching program	.046

First the difficulty values for each of the items and then the total difficulty values for each teacher regarding the shortcomings caused by educational practices that underlie the problems that students experience in reading were calculated. High numerical values of the items indicate that the difficulty levels of the items are high and that these items pose a high risk in terms of the shortcomings caused by educational practices. Based on all the data obtained, it was found that the total difficulty values ranged from the highest, 7.781 to the lowest, .437.

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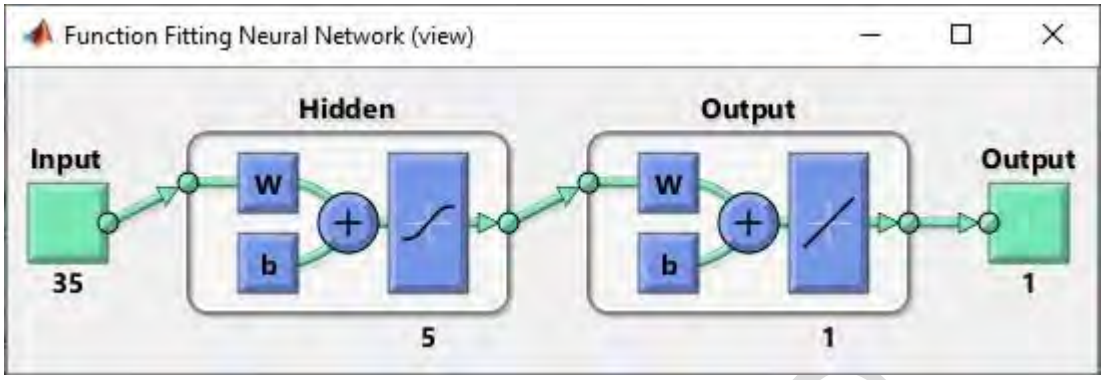

Figure 1. The ANN architecture created based on forecast for shortcomings caused by educational practices that underlie the reading problems experienced by the students

As seen in Figure 1, the students were included as input variable in the architecture with 35 items on the shortcomings caused by educational practices that underlie the problems that students experience in reading; and five neurons were used in the hidden layer and a single output value was obtained.

Figure 2 is a regression graph of the model created for the shortcomings caused by educational practices that underlie the reading problems experienced by the students. As seen from Figure 2, the model estimates the specified individual factors with full accuracy.

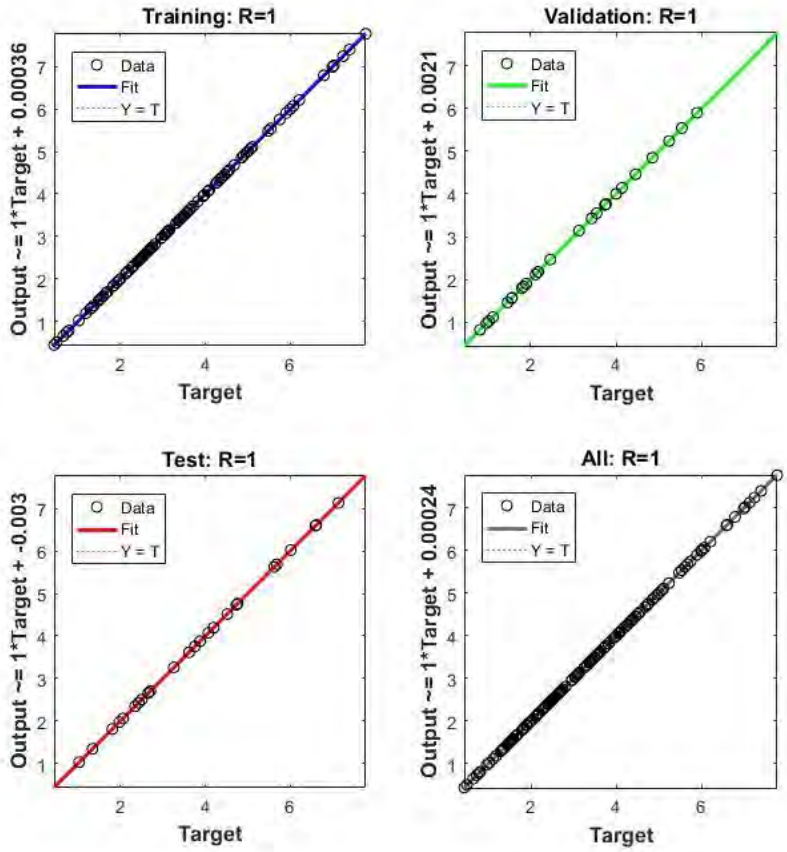

Figure 2. Regression Graph of the forecast model of the shortcomings caused by educational practices that underlie the reading problems experienced by the students

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The developed model predicts the shortcomings caused by educational practices that underlie the problems that students experience in reading with 100% accuracy both in the educational set, in the control set and in the test set.

The error graph (Figure 3) of the model developed for the shortcomings caused by educational practices that underlie the problems that students experience in reading, clearly shows that the error rate is very close to zero. Based on these results, it seems that the developed model has a fairy low error rate.

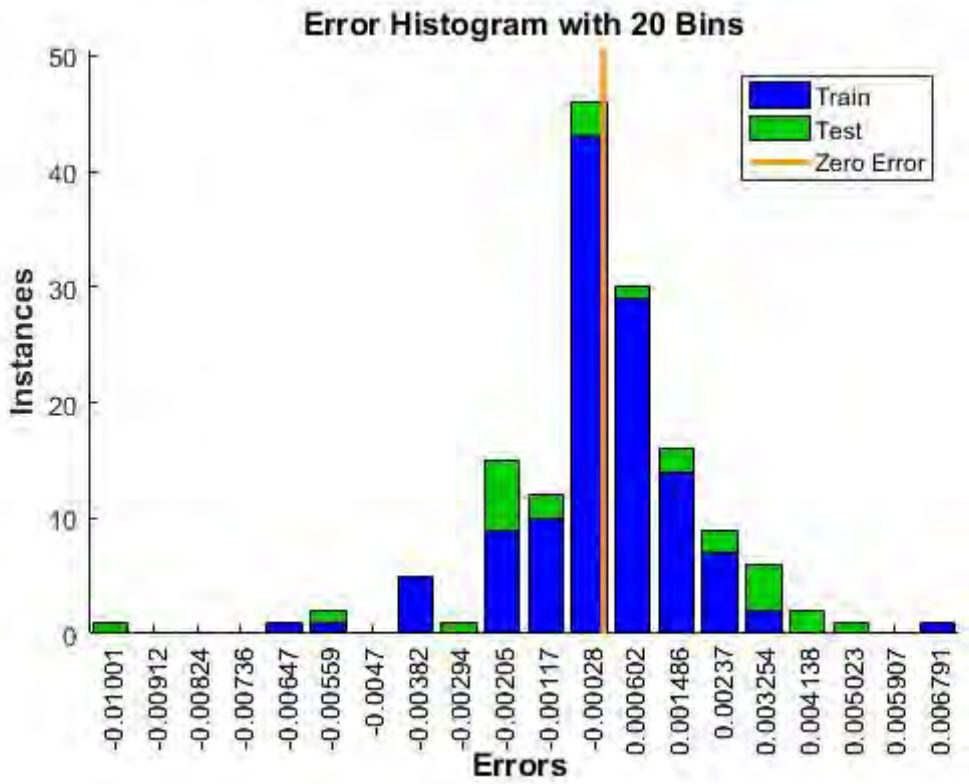

Figure 3. Error histogram of the forecast model of the shortcomings caused by educational practices that underlie the reading problems experienced by the students

The error value ranging between "-0.01001" and "+0.006791" indicates that the targeted prediction model has a very low error rate.

Figure 4 shows the performance graph of the model. As per the stopping criterion set in this architecture, the training stage was terminated at 173 cycles.

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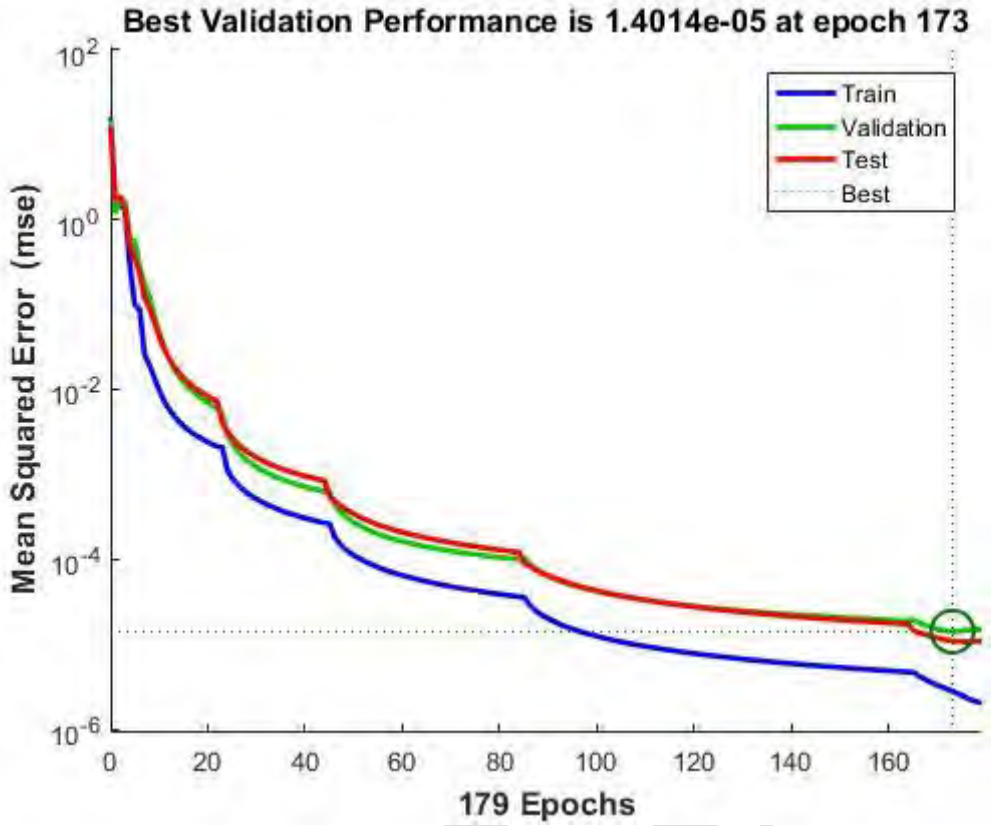

Figure 4. Performance graph of the forecast model of the shortcomings caused by educational practices that underlie the reading problems experienced by the students

Classification Modeling

This model intends to classify the difficulty levels of the reading problems identified and of the factors causing the reading problems, and to determine the relative effects of the items on the modeling for each model developed. The relative effects of the items on output values were determined by *Garson's Algorithm* proposed by (Ibrahim, 2013) David Garson.

The ANN model designed on the basis of classification was trained with the (traingdx) optimization algorithm, "*Gradient descent with momentum and adaptive learning rate back propagation*." As an activation function in the hidden layer "*Hyperbolictangent sigmoid*" (tansig) was used. The number of neurons used in the hidden layer varied for each model to develop the best training model. The default training parameters, besides the number of neurons, were used in the entire ANN architecture created. The stopping criterion in the training stage was 6 cycles when the performance of the control set did not improve. 70% of the data set was used as a train set; 15% was as a validation set and the remaining 15% was as a test set. These data were randomly selected by the system during each training. *Crossentropy*was used as a performance indicator in the evaluation of models. The findings of the classification modeling developed are presented under the following headings.

Classification modeling of the shortcomings caused by educational practices that underlie the reading problems experienced by the students. Figure 5 indicates the ANN architecture created for the classification model that is intended to be developed. Figure 5 shows that the students were included as input variable in the architecture with 35 items on the shortcomings caused by educational practices that underlie the problems experienced by the students in reading; and 10 neurons were used in the hidden layer and two different classification values as low difficulty level and high difficulty level were obtained.

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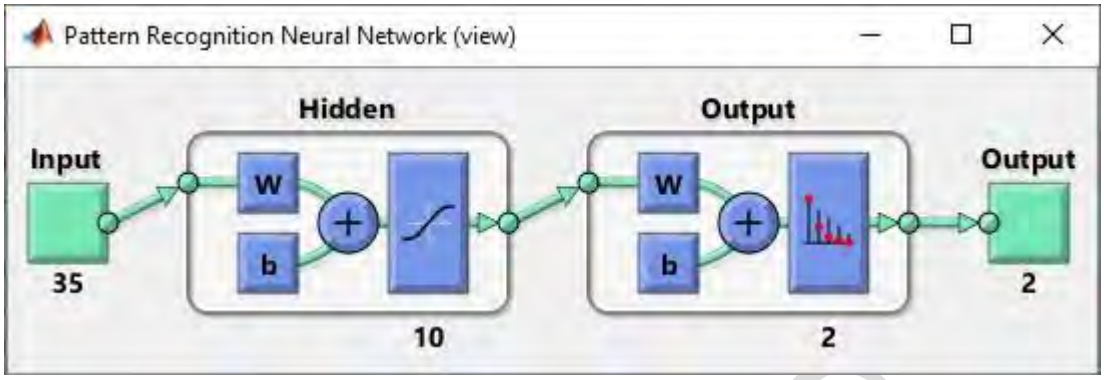

Figure 5. The ANN architecture created based on classification for shortcomings caused by educational practices that underlie the reading problems experienced by the students

Figure 6 presents the classification graph for the developed model. Figure 6 demonstrates that the developed model predicts the items with the low and high difficulty levels with 100% accuracy in both the control set and the test set and the training set.

Figure 6. Classification graph, confusion matrix of the model of the shortcomings caused by educational practices that underlie the reading problems experienced by the students

Figure 7 demonstrates the performance graph of the model. The architecture designed was terminated at 165 cycles. There was no improvement following this threshold in the control set data.

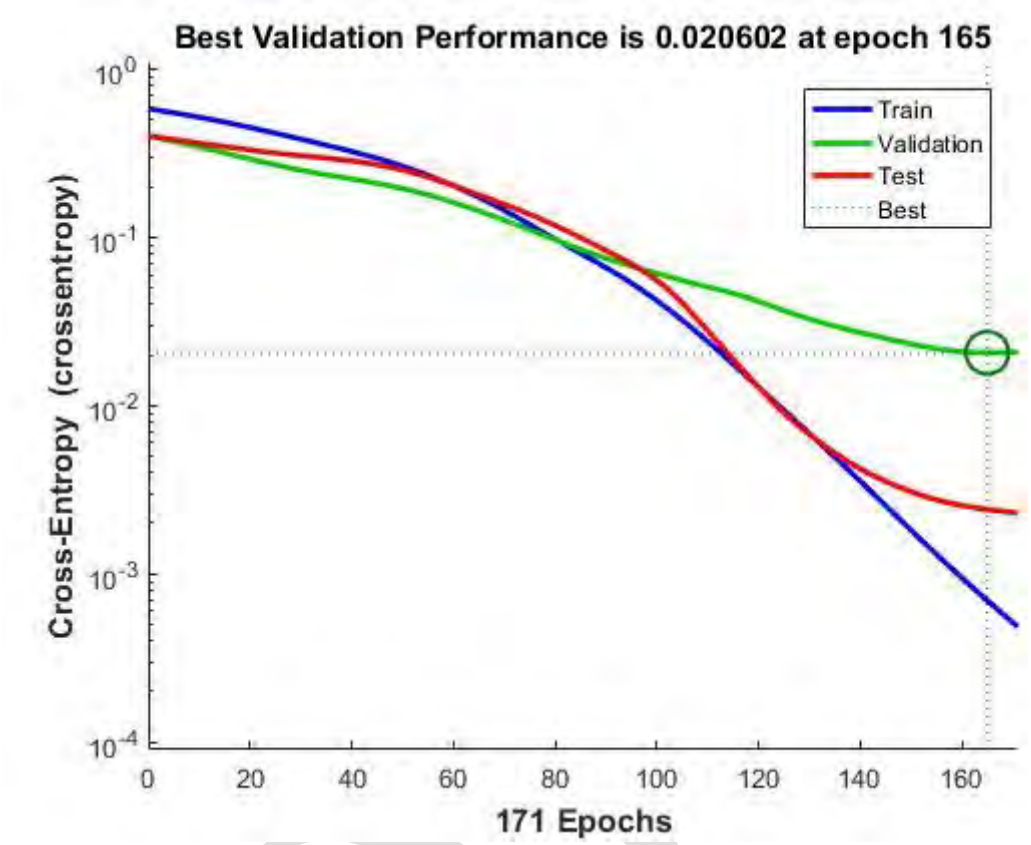

Figure 7. Performance graph of the classification model of the shortcomings caused by educational practices that underlie the reading problems experienced by the students

Table 3 shows the relative effects of the output variables of the items in the model developed for the shortcomings caused by educational practices that underlie the reading problems experienced by the students. As evident in Table 3, the first three items with the most impact on the output variables are, respectively, "Not allocating enough time for extracurricular reading", "The mandatory implementation of only a single method in reading instruction", and "Efforts to keep up with the curriculum and achievements."

Table 3. The impact weights of the shortcomings caused by educational practices that underlie the reading problems experienced by the students on the classification model

Shortcomings Caused by Educational Practices	Percentage
Not allocating enough time for extracurricular reading	4.61%
The mandatory implementation of only a single method in reading instruction	4.60%
Efforts to keep up with the curriculum and achievements	4.43%
The design of the curriculum failing to recognize individual differences	4.43%
Changes in primary literacy instruction	4.29%
Achievements in the Turkish language course being mostly grammatically focused	3.88%
Italic-cursive writing application	3.84%
Activities outside the teaching program	3.61%
No chance of repeating the grade	3.40%
Crowded classrooms	3.37%
Lack of regional curriculum applications	3.03%
Teachers with no reading habits	3.00%
Early school starting age	2.94%
Texts in the textbooks too advanced for students	2.89%

Table 3 (Continued). The impact weights of the shortcomings caused by educational practices that underlie the reading problems experienced by the students on the classification model

Shortcomings Caused by Educational Practices	Percentage
Lack of practices that encourage reading	2.83%
Exam-oriented teaching	2.82%
Lack of a mechanism to monitor reading progress	2.82%
Attaching great emphasis and importance to evaluation in the form of tests	2.66%
Failure to provide encouraging reading environments	2.63%
Lack of up-to-date and qualified books in school libraries	2.62%
In-class competition/competitive climate	2.56%
Lack of technology and materials in schools	2.54%
Multi-grade classroom teaching practices	2.52%
Changes in teaching staff (timed/untimely)	2.43%
Reading activities not being valued at the school level	2.26%
Lack of consensus on writing method	2.22%
Poor physical infrastructure of schools	2.21%
Lack of library	2.18%
Hasty approach to reading instruction	2.06%
Competitive approach towards reading instruction among teachers	1.98%
Teachers' lack of professional competence	1.96%
Teachers' lack of interest in reading	1.96%
Teachers' preference for books or reading materials that are not appropriate for the grade level	1.72%
Uniformity of textbooks	1.50%
Teachers' failure to adequately support students with reading problems	1.17%
Total	**100%**

DISCUSSION, CONCLUSION, and SUGGESTIONS

It is important to follow students' reading progress, to predict current reading problems and future reading problems, and to design appropriate methods and techniques for preventive programs (Görgün & Melekoğlu, 2022; Morris, & Gill, 2023; Spear-Swerling, 2013). To prevent them, it is further significant to determine the reasons for the problems experienced by students who do not have a physical or mental problem that will prevent them from reading, but still have problems in reading. In this way, the identification of the students who have problems in reading helps preventive work that involves creating level groups when needed and determining the reading risk maps of the students.

This study identifies the factors of non-cognitive shortcomings caused by educational practices that underlie the reading problems of students, and develops a preventive model with Artificial Neural Networks. This new model helps determine possible reading problems that students may experience due to the shortcomings caused by educational practices. The goal here is to implement preventive programs aimed at eliminating these reasons. Thanks to this model, which investigates the reasons of the reading problems, the schools where the students receive education are evaluated, and suggestions to overcome the factors that affect the students will guide the relevant authorities.

Given that the number of students with reading difficulties receiving support education through special educational practices or remedial programs can be reduced by up to 70% with early identification and prevention programs, (Lyon et al., 2001) it seems that preventive activities can be much more effective in minimizing the number of students who have not or could not be identified. In this regard, this study focuses on the students who have not been diagnosed with a reading disability or do not have any learning disability, but still have problems in reading. A total of 231 classroom teachers participated in this study. Considering that there are an average of 21 students per classroom in Turkey (MEB, 2018a), this study indirectly obtained data on approximately 4,851 primary school students.

The research findings yield that the academic achievements of students are closely related to a well-designed curriculum, and it is known that many countries have systems that monitor, evaluate

curriculum practices and track student success (Hooper et al., 2016). From this standpoint, the items such as "The design of the curriculum failing to recognize individual differences", "The mandatory implementation of only a single method in reading instruction", "Changes in primary literacy instruction" and "Lack of regional curriculum applications" are directly related to the curriculum. "Lack of a mechanism for monitoring reading progress" is considered a weakness of the Turkish language course curriculum.

An education system is only as good as its teachers (UNESCO, 2013); therefore, the improvement of reading skills of students and the elimination of reading problems that have been experienced or are likely to be experienced is closely related to the professional experience of teachers. In the qualitative part of this study, the teachers personally mentioned "Teachers' lack of professional competence", which was then marked by 12% of the teachers in the quantitative part; this simply means that some of the teachers who participated in this study were self-critical in this regard. In fact, this finding is further supported by other research. A relevant study argues that classroom teachers need in-service training on literacy instruction, which also may help preventing incorrect practices that might be performed in the future (Aydın & Kartal, 2017).

It is believed that school facilities and physical facilities, as well as the qualifications of teachers, have an impact on student achievement, and consequently on their reading progress. These include proper school facilities with well-trained teachers, adequate classroom space and other advanced school facilities (Cheryan, Ziegler, Plaut, & Meltzoff, 2014; Kapoor, Kumar, Meena, Kumar, A., Alam, Balam, & Ghosh, 2021; Schneider, 2002). The scope and quality of the school resources, materials and human resources are critical to a quality education and also in a strong relationship with students' reading and math achievements (Lee & Zuze, 2011; Yang, & Lee, 2022). From this perspective, the items "Poor physical infrastructure of schools" and "Lack of technology and materials in schools" are closely associated with the reading skills of the students. As for the effects on student achievement, comparing school facilities and teacher qualifications, it is evident that teacher qualifications have a much greater effect than inter-school variable factors (Hattie, 2009; Manning, Wong, Fleming, & Garvis, 2019).

Another addition to the school facilities should be classroom libraries or school libraries. When it comes to reading skills and reading problems, libraries become more significant. It is known that there is a solid relationship between reading success and the use of school libraries (Clark, 2010; Stewart, 2018). Therefore, "Lack of library", "Lack of up-to-date and qualified books in school libraries" and "Failure to provide encouraging reading environments" to children at schools directly or indirectly cause children to have reading problems. Classroom libraries, like school libraries, which can be established within the bounds of possibility, also contribute to the reading motivation of students. Also, classroom libraries may encourage children's positive attitude towards reading. Indeed, it is reported that classroom libraries can help improve reading habits and reading attitudes among children (MacKay, Young, Munòz, & Motzkus, 2020; Omigie, & Idiedo, 2019; Young & Moss, 2006).

It is believed that teachers, like school libraries and classroom libraries, also motivate students to read. To increase student motivation for reading, it is important that teachers read as well (Cremin, Mottram, Collins, Powell, & Safford, 2009; Merga, & Ledger, 2019); research show that children who are more motivated to read, especially at an early age, will become better readers in the future (Lewis & Samuels, 2003; Nevo, & Vaknin-Nusbaum, 2020; Wigfield, Gladstone, & Turci, 2016; Wigfield, Guthrie, Tonks, & Perencevich, 2004). For this reason, "Teachers' lack of interest in reading" and "Teachers with no reading habits" are just some of the issues that will prevent students from reading. This also determines the quality of the books that teachers will choose in reading activities. Teachers' selection of books that are not of interest to students may have a negative impact on students' attitudes towards reading. The reading material and technology used by teachers in reading instruction underlie students' reading experiences at school (Hooper et al., 2016). For this reason, "Teachers' preference

for books or reading materials that are not appropriate for the grade level" may adversely affect the reading experiences of students in the educational process.

Research indicate that the cooperation between teachers enhances the learning experience of students (Ainley, & Carstens, 2018; Goddard, Goddard, & Tschannen-Moran, 2007; Hargreaves, 2019; Vangrieken, Dochy, Raes, & Kyndt, 2015). Here, it is important to note that teachers who adopt "Competitive approach towards reading instruction among teachers" negatively affect the learning progress of students knowingly or unknowingly.

It is stated that if well managed, multi-grade classroom teaching practices provide students with the opportunity to develop individually in the subjects they are talented and interested in (Köksal, 2005). However, considering that not all classroom teachers have sufficient knowledge and equipment about multi-grade classroom teaching practices (Köksal, 2005) "Multi-grade classroom teaching practices" are of critical importance in developing reading skills.

The model developed in this study will hopefully allow predicting and classifying the causes of possible reading problems that students may experience through the criteria specified by evaluating the educational practices that students benefit from.

Limitations and Suggestions

This research is limited to the third grade primary school teachers working in the province of Eskişehir in the 2019-2020 academic year.

Through the items identified in the qualitative part of this study as well as the checklist with these items applied in the quantitative part, forecast and classification models have been developed via artificial neural networks. It is notable that the full accuracy and near-zero error rates of the developed models ensures that the validity, inclusivity and reliability of the data obtained as well as the predictability of the opinions of the teachers on the shortcomings caused by educational practices that underlie reading problems are high.

According to the results of the research, the following suggestions can be made for practitioners and educational researchers:

Reading risk maps of the students may be formed both on a city-by-city and country-by-country basis through the models developed under this current research, and this might facilitate implementing preventive programs quickly.

This study, identifying the reading problems experienced by the students, offers an artificial intelligence model that will help creating classes by level for students with similar reading problems based on the difficulty levels of the reading levels experienced by the students. In this way, specific measures and interventions aimed at eliminating reading problems may be implemented.

To find educational practices that have an impact on reading, the schools where children study may be screened and a "risk map of educational practices that have an impact on reading" can be created through the model developed.

Another effective approach in this regard would be to design a curriculum that recognizes the wishes and needs of the students as well as considers the environmental conditions. Extracurricular reading in schools may be promoted, and teachers may be encouraged to take more initiative in choosing reading materials and using selected reading materials in lessons.

It should be mandatory to establish libraries in all schools and to equip them with qualified children's books. Classroom libraries need to be mandatory, within the bounds of possibility, and this may directly support the development of students' reading skills.

To allow for better reading and learning, the necessary legal regulations may be enforced to abandon classroom teaching practices or to perform teaching in separate classrooms in schools with adequate classrooms and teachers regardless of the number of students.

In elementary schools, which are considered critical in the acquisition of reading skills, “Reading specialists” should be staffed to monitor the reading progress of students; these specialists should be only asked to deal with reading problems and progress.

Interesting reading activities can be organized in schools to engage children's interest in reading. It is necessary to carry out frequent collaborative and interactive book reading sessions, such as reading aloud and recounting what you are reading, in schools.

Activities can be designed to involve parents in educational practices. Thus, school and family cooperation can be achieved.

The attitudes and competencies of their teachers, who children consider as role models, towards reading are critical. The relevant ministry may carry out practices to improve these attitudes and competencies. In order to contribute to teachers' access to books, financial support for the purchase of books may be given every year. Teachers may be provided with an unlimited and smooth access to local and foreign academic resources that will contribute to their professional development.

Educational practices and the causes of reading problems based on the opinions of students and parents in future research may investigate. Thus, the views of all stakeholders who affect reading can be revealed with their own perspectives and experiences.

Ethics and Conflict of Interest

Before the applications were carried out, the participants were informed about the research’s purpose and scope, and it was declared that there was no ethical violation. Therefore, the ethical committee approval was obtained for this research from Bursa Uludağ University Scientific Research Ethics Committee with the decision numbered 2019/10 dated 29 November 2019. All rules required by research ethics were complied with while conducting this study. And also the authors declare that there has no conflict of interest between them. The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. This study is complied from the master’s thesis titled as “Modelling reasons for reading problems experienced by third graders through artificial intelligence method” which was conducted at the Institute of Education Sciences of Bursa Uludag University in 2020 by the supervision of second author.

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