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HEURISTIC ANALYSIS OF THE NATIVE LANGUAGE CURRICULUM OF SUCCESSFUL COUNTRIES IN PISA AND TURKEY BY USING ANFIS

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ABSTRACT

Background and Purpose: This study analyzes the native language curricula of countries that consistently perform well in the Programme for International Student Assessment (PISA) by employing the Adaptive Neuro-Fuzzy Inference System (ANFIS). It aims to evaluate the relationship between learning outcomes in listening, speaking, reading, and writing skills and PISA results, providing insights into curriculum effectiveness.

Methodology: A convergent parallel mixed-method approach was adopted, combining document analysis and statistical modelling using ANFIS. The study examined learning outcomes and codes associated with language skills from the curricula of selected countries and compared these with PISA scores to identify correlations and trends.

Findings: The results indicate that coupled relationships between specific language skills, such as reading and writing, have a stronger influence on PISA performance compared to implementing all skills simultaneously. Countries with fewer learning outcomes, such as Singapore, demonstrate higher PISA scores, suggesting that quality and strategic focus in curriculum design outweigh sheer quantity of outcomes.

Contributions: This study introduces ANFIS as an effective tool for analyzing and optimizing native language curricula. It provides valuable recommendations for enhancing accountability, alignment, and efficiency in language education programs. The findings contribute to the development of curricula that align with international benchmarks, supporting educational systems in achieving higher academic performance.

Keywords: ANFIS, native language curriculum, artificial intelligence modelling techniques, successful countries, PISA.

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1.0 INTRODUCTION

In general, the native language, which is the language that a person learns first from his family and later from the community to which he is connected, is not a stationary structure but a skill that continues to develop throughout his life. It is the common language learned within the opportunities provided by the current social environment. As in the case of Singapore and South Korea, since it was announced that the best teaching tool is the child's native language, mother tongue education and teaching have taken their place as the core of literacy research (Letsholo-Tafila & Ramaeba, 2022). Aksan (2004) defined native language as a language that is initially learned from the mother and the immediate family environment, and then from the associated area, descending into the person's subconscious and forming the strongest connections of the person with society.

The role of the native language is significant in the development of language skills and the advancement of communication skills in the acquisition of a number of personal and social values of individuals. Farhodqizi (2022) focused on the benefits, usefulness and impact of using the student's native language in the educational environment in the process of learning even a second language. The fact that children are multilingual also allows them to acquire more than one grammar and educational understanding (Gulnoza, 2023). The development of different learning and intelligence areas is also possible by reaching a competent level in native language.

The importance of the mother tongue is realized by the fact that we can form sentences thanks to the mother tongue (Banguoğlu, 2015). Learning the rules and structure of a common language, which meets all linguistic needs, occurs through educational environments. Native

language, whose influence in education cannot be ignored, has been programmatically included in every educational system. Native language teaching also appears as a 'native language teaching program' in organized and planned documents in educational systems. A person will learn the basic language skills and structure of a common language that is part of the native language curriculum in this learning process and use it in their daily life. In order to develop basic language skills and achieve success in other areas of learning, the native language is the child's assistant in all courses, including foreign language courses, and should be used systematically (Butzkamm, 2003).

There are international student assessment programs in which the achievement levels of reading skills in the mother tongue of the countries are revealed. PISA is one of these programs based on mathematical literacy, science literacy and reading comprehension skills in the native language. It reveals the educational success of OECD member countries within the framework of these limitations. This exam, conducted every three years, selects students in the age group of 15 by a non-selective method.

This research covers Singapore, Hong Kong, South Korea, Ireland, Finland, Canada, which consistently achieved success in the top 10 and Sweden, the United States native language programs, whose ranking has risen significantly in PISA. Turkey is included to compare.

There are many studies in the literature related to PISA exams, literacy tests, students' reading skills, student attitude questionnaires, education systems of different countries (Karakoç Alatlı, 2016; Bağdu Söyler, 2020; Yüksel, 2019; Ceyhan, 2019; Tiryaki, 2019; İnce, 2016; Özmen, 2013; Espinoza, 2019; Akkuş, 2014; Kara, 2001; Alma, 2005; Yazıcı, 2009; Kırat, 2010; Tosun, 2012; Balıdede, 2012; Yılmaz, 2017; Erparun, 2017; Gülsoy Kerimoğlu, 2019; Kutluca Canbulat, 2004). It is hoped that this study, in which the native language teaching programs of successful countries are examined and the data obtained are analyzed using the ANFIS technique, will contribute to the literature.

The aim of the research is to analyze the native language curriculum of Singapore, Hong Kong, South Korea, Ireland, Finland, Canada, Sweden, United States and Turkey with ANFIS in the PISA application conducted in 2012, 2015 and 2018. From the content of the native language programs, the number of learning outcomes and number of codes for each skill were determined in the research. For the purpose of the research, answers to the following sub-problems were sought:

1. What are the contents of native language curriculums of Singapore, Hong Kong, South Korea, Ireland, Finland, Canada, Sweden, The United States and Turkey?
2. What are the results of analyzing the number of codes and the number of learning outcomes obtained from the content of native language programs by ANFIS?

2.0 LITERATURE REVIEW

2.1 High Ranking Education Systems and Artificial Intelligence

Education is a structure that is carried out in this system in the most general sense. Educational programs, which form the basis of educational systems, are created according to the innovations of each semester and the needs of each country. In line with this, it is necessary to take an example of the advanced educational systems and follow international innovations. PISA (Program for International Student Assessment) is one of the most comprehensive educational research in the world, organized by the organization for Economic Co-Operation and Development (OECD). PISA is implemented every three years in order to follow international innovations in education and to evaluate developing educational systems by taking an example. In PISA, which covers the fields of reading, mathematics and science, 15-year-old students representing each country are selected by an unselected method. Since 2000, PISA, may provide equitable learning opportunities for all high-quality teaching and the education system has shown that lays out what students are doing to support their own countries and other countries, has become a document that provides the opportunity to learn from each other at a point (PISA - OECD, 2019).

Based on the reading section, the scores and rankings of countries that have been consistently in the top 10 and whose ranking has risen significantly in the last three periods are shown in Table 1:

Table 1: Successful countries in PISA by year

Country	**2012**		**2015**		**2018**	
	Point	***Rank***	**Point**	**Rank**	**Point**	**Rank**
In the top 10						
Singapore	542	3.	535	1.	548	2.
Hong Kong (China)	535	2.	527	2.	524	4.
South Korea	536	5.	517	7.	514	9.
İreland	523	9.	521	5.	518	8.
Finland	524	6.	526	4.	520	7.
Canada	523	8.	527	3.	520	6.
Rising ranking						
Sweden	483	37.	500	18.	506	11.
The United States	498	24.	497	24.	505	13.

Considering that many of the courses taught at schools are based on understanding, a student who cannot understand what he is reading, who is not able to interpret information that is presented in the text, cannot be expected to succeed in any of his courses and he also cannot acquire skills such as reading-learning, coping with exams, problem solving and critical thinking, which he has gained with his native language skills (Karatay, 2009). PISA can be seen from the results; a successful instructional program is located in each country's native language in a comprehensive manner, and both academic achievement and communication skills, influencing skills through reading text messages in the most general sense is the process of performing a mental process by detecting the sensory organs.

In order to benefit from reading, which is an important variable in a student’s personal, academic and social development and reading motivation, which is one of the dynamics that is also effective for students to turn to read and be a good reader, should be provided and the fact that it leads to success in other areas of learning, should also be adopted (Yıldız & Akyol, 2011).

The research is significant in terms of directing and contributing to the development and re-preparation of the programs that one will design at the national level based on the native language teaching programs. In addition, given the advances in emerging technology and science, one also see traces of the use of artificial intelligence in the field of Education. The use of ANFIS, a statistical technique based on artificial intelligence methods, is also of great importance, especially at the point of finalizing uncertain data that one encounters in the Social

Sciences. ANFIS (Adaptive Neuro Fuzzy Inference System) is an adaptive network approach consisting of a combination of Fuzzy Logic and ANN (Artificial Neural Networks) (Klir & Yuan, 1995). Fuzzy logic, which appeared in 1965 by Lotfy A. Zadeh, is the most important advantage compared to other methods in different disciplines with the ability to evaluate the uncertainty and it has contributed to the development of artificial intelligence Studies (Zadeh, 1965; Güner & Çomak, 2014). ANN, artificial neural networks, is a flexible modeling tool.

3.0 METHODOLOGY

3.1 Research Design

The mixed method was used in the research due to using quantitative and qualitative data. The mixed method is based on better understanding and studying research problems and questions using quantitative and qualitative methods together (Creswell, 2008; Fraenkel & Wallen, 2006). The mixed method is divided into three patterns: sequential explanatory mixed method, convergent parallel mixed method and exploratory sequential mixed method. In this study, the 'convergent parallel mixed method' was used to collect qualitative and quantitative data together. The data was analyzed separately, and the findings were compared to determine whether the findings confirm each other. The basic assumption in this approach was that qualitative and quantitative data provide different types of information (Creswell, 2016).

3.2 Research Sampling

In this research, the native language curricula of Singapore, Hong Kong, South Korea, Ireland, Finland, and Canada, which have been consistently successful in the top 10, and Sweden, and the United States, whose ranking has been rising in the reading part of the 2012, 2015 and 2018 PISA application conducted in the last three periods, was taken as a sample. The research consists of using ANFIS to analyze the native language curriculums of the countries. In this context, native language curricula of Singapore, Hong Kong, South Korea, Ireland, Finland, Canada, Sweden, The United States and Turkey were studied.

3.3 Data Collection Process

In this research, at first, document review, which is one of the qualitative research methods, was used to investigate native language programs of Singapore, Hong Kong, South Korea, Ireland, Finland, Canada, Sweden, The United States and Turkey to collect ANFIS data. Native language teaching programs are obtained from the official education ministries of each country. The digital version of the Finnish program has not been reached and has been compiled from

different sources (Erdoğan & Gök, 2011; Demirtaş, 2013; Sefer, 2015; Yıldız; 2015; Aslantaş, 2017) and made into a whole. Qualitative research; behavior observation, interviews with participants, and qualitative data collection methods such as document review and the findings from the data collected through a qualitative research process are viewed in a holistic way to reveal what is expressed in the form of a process (Creswell, 2016; Yıldırım & Şimşek, 2013). Document review covers the gradual analysis of materials based on the facts or the facts that are intended to be investigated (Yıldırım & Şimşek, 2013). The number of learning outcomes and the number of codes of four language skills taken jointly in each program with a research document were determined. The native language programs in question, which constitute the research documents, were analyzed using the ANFIS method.

Adaptive Neuro Fuzzy Inference System is an adaptive network approach consisting of a combination of Fuzzy Logic and Artificial Neural Networks (ANN) (Klir & Yuan, 1995). Fuzzy logic, appearing by Zadeh, which is the most important tool compared to other methods in different disciplines with the ability to evaluate uncertainty and ANN, flexible modeling tool, contributed to the development of artificial intelligence studies (Zadeh, 1965; Güner & Çomak, 2014).

4.0 ANALYSIS AND DISCUSSION

In this research, the content analysis method was used to analyze the data obtained by examining the native language curriculum in question. The analysis of the content that is faced in the field of Social Sciences, based on specific rules outlined with smaller categories of the content encoding of the text with some of the words, systematic, replicable technique is defined as concepts and relationships that can explain the collected data and the idea is to achieve (Büyüköztürk, 2018; Yıldırım & Şimşek, 2013).

In this context, the number of learning outcomes and the number of codes of four language skills taken jointly in each program with a research document were determined. The native language programs of Singapore, Hong Kong, South Korea, Ireland, Finland, Canada, Sweden, The United States and Turkey were reached from each country's own official education ministries and divided into sub - elements such as ‘code and theme’ and analyzed with ANFIS after comparison. In this analysis, code and theme content categories created from skills in countries’ programs were used.

The skills in the native language curriculum of the countries involved in the research are as follows in the Table 2:

Table 2: The skills in the native language curriculum of the countries

Skills	**Country**
Listening and Viewing Reading and Viewing Speaking and Representing Writing and Representing Grammar	Singapore
Listening Speaking Reading Writing Grammar	Hong Kong
Listening Speaking Reading Writing Grammar and Literature	South Korea
Oral Language Reading Writing	İreland
Communication Skills Text Comprehension Oral Presentation Language and Literature	Finland
Oral Communication Reading Writing Media Literacy	Canada
Reading and Writing	

Speaking, Listening, Talking	
Narrative texts and Non-fiction text	Sweden
Use of Language	
Searching for information and	
Critical evaluation of sources	
Reading	The United States
Writing	
Written And Oral English	
Language Convention	
Listening and Speaking	

The skills common to all of the country's programs were identified as 'listening-speaking-reading-writing'. Then, the number of codes and the number of learning outcomes obtained in each skill from each country's native language curriculum were compared with the 2018 PISA scores. Four different combinations were created in the comparison based on reading ability: 'reading-listening', 'reading-speaking', 'reading-writing' and 'reading-listening-speaking-writing'. These four different combinations mean four separate models in the ANFIS part. The aim of the modeling was to determine the relationship between the number of codes and the number of learning outcomes for 'reading-listening', 'reading-speaking', 'reading-writing' and 'reading-listening-speaking-writing' skills with the PISA score by using ANFIS. A development tool is required to implement ANFIS architecture (Al-Hmouz et al., 2011). For this purpose, MATLAB (matrix laboratory) Program, a multi-paradigm numerical calculation software, was used. Combination models created in the MS Office Excel table environment were analyzed using the ANFIS method in MATLAB.

Adaptive Network-based fuzzy inference system (ANFIS) is an adaptive network approach which consists of a combination of Fuzzy Logic and artificial neural network (ANN). ANFIS, consisting of the initials of the Adaptive Neuro-Fuzzy Inference system, operated by Sugeno-type fuzzy inference systems, is given input and output values, and ANFIS creates a fuzzy inference model using the method of spreading these values back or the least squares method (Çakıroğlu et al., 2011).

Fuzzy logic, unlike boelean logic, is a flexible method of calculation, which allows to define the uncertainty states that may be encountered in normal life. This allows us to obtain

approximate results of uncertainty, which are the most commonly used Soft Computing Techniques introduction to fuzzy logic, database, fuzzification unit, the fuzzy inference mechanism, rule base, and defuzzification the output section comprises a unit (Jang, Sun, & Mizutani, 1996). The expressions 'good, long, successful, warm' in definitions such as 'good person, tall height, successful student and warm water', which are considered approximate information, are linguistic definitions. Because they contain relativism, they are considered fuzzy concepts. They need to be digitized by being treated on a relative plane (Tütmez, 2008). Particularly in Social Sciences, the use of data in the analysis of which one cannot definitively determine the limits will allow to achieve more successful results.

The selection of ANFIS, a non-linear regression method, is related to this achievement. Multiple regression models have been tried, but nonlinear regression has been used due to high uncertainty in the data. A regression analysis is a type of regression analysis that involves modeling whether there is a regression between two nonlinear variables in statistics with a function with one or more independent variables and it is adopted, particularly for research purposes in Social Sciences.

Artificial Neural Networks (ANN), which have a wide range of applications, can perform classification, clustering, experimental design, modeling and it can specially be designed for almost any type of data to solve different types of problems (Zupan, 1994). Since it can find solutions to different types of problems, it can solve the existing problem using a special network system. ANFIS, a combination of Fuzzy Logic and ANN, needs input and output values for modeling. For the 'input' value, the number of codes and the number of learning outcomes in reading-listening, reading-speaking, reading-writing, and reading-listening-speaking-writing skills were used while the 'output' value was the PISA scores. Among the most commonly used membership functions in ANFIS is the 'Gaussian' function, as expressed in eq.1, which was used to define fuzzy sets since it reaches smoother representation at each point (Sadollah, 2018).

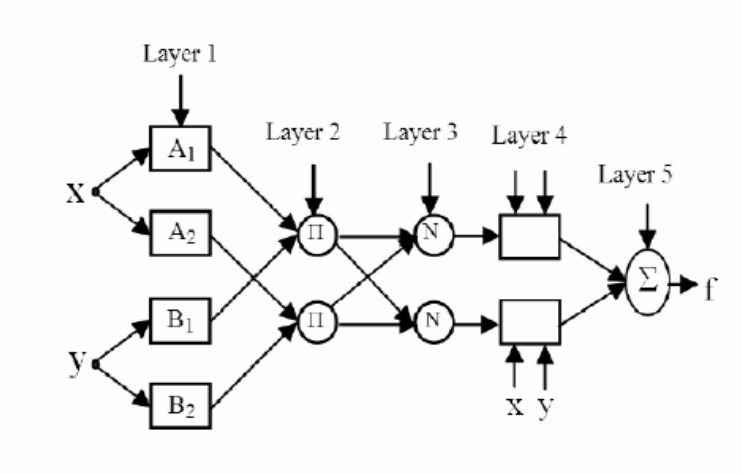
$$\mu_A(x,c,s,m) = \exp\left[-\frac{1}{2}\left|\frac{x-c}{s}\right|^m\right] \quad (1)$$

Assuming 'x' 'y' are the input and 'f'' is the output of a fuzzy inference system, the first-order Sugeno type has the following rules as given in eq. 2 and 3:

Rule (1): if $\mu(x)$ is A_1 and $\mu(y)$ is B_1; then $f_1 = p_1x + q_1y + r_1$ (2)

Rule (2): if $\mu(x)$ is A_2 and $\mu(y)$ is B_2; then $f_2 = p_2x + q_2y + r_2$ (3)

For given inputs x and y, the membership function are indicated as A_1, B_1, A_2, B_2, and the outlet functions' parameters are $p_1, q_1, r_{1,} p_2, q_2, r_{2,}$. The general structure of the 2-input ANFIS which was used in the research was as followed:



Layer 1: The node function of this layer is an adaptive node i (see eq. 4):

$Q_i^1=\mu_{Ai}(x)$ for i=1,2 or $Q_i^1=\mu_{Bi}(x)$ for i=3,4 (4)

$Q^1{}_i$ stands for the membership grade for x and y inputs and the selected membership function was a Gaussian membership function because it has reduced the error in the prediction process.

Layer 2: Each input layer was linked with an operator called a T-Norm that was accomplished with an 'AND' operator (see eq. 5):

$Q^2{}_i=w_i=\mu_{Ai}(x).\ \mu_{Bi}(y)$ for i=1,2 (5)

Layer 3: The output in this layer is known as normalized firing strength and each node was labeled as Norm (see eq. 6):

$$Q_i^3 = \overline{w}_i = \frac{w_i}{w_1 + w_2} \text{ i=1, 2} \quad (6)$$

Layer 4: In this layer, each node i performed the subsequence rules as an adaptive node (see eq. 7):

$$Q_i^4 = \overline{w}_i(p_i x + q_i y + r_i) = \overline{w}_i f_i \tag{7}$$

$p_1, q_1, r_1,$ were the irregular parameters referred to as consequent parameters.

Layer 5: The product of all the incoming signals was computed for the overall output layers (see eq. 8):

$$Q_i^5 = \overline{w}_i(p_i x + q_i y + r_i) = \sum_i \overline{w}_i f_i = \frac{\sum_i w_i f_i}{\sum_i w_i} \tag{8}$$

According to the results obtained from the datasets, the model's ability to decouple between the inputs and the outputs was analyzed by using statistical methods. The statistical models used were computed by the Root mean square error (RMSE) and the coefficient of determination (R2) as given in eq. 9 and 10 respectively:

$$\text{RMSE}=\sqrt{\frac{1}{n}\sum_{i=1}^{n}(\hat{\gamma}_i-\gamma_i)^2} \tag{9}$$

$$R^2=1-\left[\frac{(\gamma-\hat{\gamma})^2}{(\gamma-\gamma_{mean})^2}\right] \tag{10}$$

Findings which were obtained after the data analysis is presented and interpreted in this section. It is included the number of codes and the number of learning outcomes obtained from language skills content in the native language programs of the countries covered by the research and 2018 PISA scores.

As in the models to be used in ANFIS analysis, the number of learning outcomes and the number of codes in a skill of each country are shown below.

Table 3: The number of codes and learning outcomes for reading and listening skills by country

	Number of codes	Number of learning outcomes	PISA Score
Reading	4	9	548
	6	28	524
	7	71	514
	6	32	518
	5	17	520
	6	72	520
	4	13	506
	8	70	505
	7	142	466
Listening	6	10	548
	6	17	524
	6	53	514
	5	31	518
	4	10	520
	8	44	520
	5	4	506
	5	51	505
	5	52	466

The number of codes and the number of learning outcomes obtained from the language skills content in native language programs of the countries covered by the research and 2018 PISA scores were demonstrated in Table 3. According to the native language programs of the countries, the maximum number of learning outcomes in reading skills was for Turkey, with 142. This number is followed by Canada, which has a total number of learning outcomes 72. Although Singapore is the country with the minimum number of learning outcomes, it also has the highest PISA result.

Considering the listening skills, the maximum number of learning outcomes in listening skills was in South Korea with 53. This number was followed by Turkey, which had a total number of learning outcomes 52. The number of learning outcomes in each skill was examined, and code was created according to those learning outcomes. Each skill has an average of 5 codes. As can be seen in the table, the maximum number of codes in reading skill was for The

United States of America with 8. The minimum number of codes was in Singapore, which has the highest PISA result.

The maximum number of codes in listening skills was in Canada with 8, while the minimum number of codes in listening skills was in Finland with 4.

Table 4: The number of codes and learning outcomes for reading and speaking skills by country

	Number of codes	**Number of learning outcomes**	**PISA Score**
Reading	4	9	548
	6	28	524
	7	71	514
	6	32	518
	5	17	520
	6	72	520
	4	13	506
	8	70	505
	7	142	466
Speaking	5	17	548
	5	15	524
	6	57	514
	5	31	518
	4	9	520
	8	36	520
	5	4	506
	5	51	505
	4	28	466

As deducted from Table 4, the maximum number of learning outcomes in speaking skills was in South Korea at 57, while the minimum number of learning outcomes was in Sweden at 4. Although the reading skill values were the same, the maximum number of codes was in Canada, with 8.

Table 5: The number of codes and learning outcomes for reading and writing skills by country

	Number of codes	**Number of learning outcomes**	**PISA Score**
Reading	4	9	548
	6	28	524
	7	71	514
	6	32	518
	5	17	520
	6	72	520
	4	13	506
	8	70	505
	7	142	466
Writing	4	13	548
	6	17	524
	6	71	514
	6	31	518
	0	0	520
	6	100	520
	4	13	506
	6	45	505
	5	67	466

As can be seen in Table 5, the maximum number of learning outcomes in writing skills was in Canada, with 100. Finland had no learning outcomes in writing skills. After Finland, the minimum number of learning outcomes was in Singapore and Sweden, with 13.

The maximum number of code in writing skills was in Hong Kong, South Korea, İreland, Canada and The United States with 6. In Finland, the number of codes was not interpreted since there was no number of learning outcomes. This number is followed by Singapore and Sweden, with 4.

Table 6: The number of codes and learning outcomes for reading, listening, speaking and writing skills by country

	Number of codes	Number of learning outcomes	PISA Score
Reading	4	9	548
	6	28	524
	7	71	514
	6	32	518
	5	17	520
	6	72	520
	4	13	506
	8	70	505
	7	142	466
Listening	6	10	548
	6	17	524
	6	53	514
	5	31	518
	4	10	520
	8	44	520
	5	4	506
	5	51	505
	5	52	466
Speaking	5	17	548
	5	15	524
	6	57	514
	5	31	518
	4	9	520
	8	36	520
	5	4	506
	5	51	505
	4	28	466
Writing	4	13	548
	6	17	524
	6	71	514
	6	31	518

0	0	520
6	100	520
4	13	506
6	45	505
5	67	466

The number of codes and the number of learning outcomes for all language skills were specified and all of them were collected in a single Table 6. The content of the tables that create the models that were used in ANFIS analysis was as described above.

PISA results based on 2018 were associated with the number of codes and learning outcomes for each skill based on the datasets obtained from native language programs of the countries within the scope of the study. Accordingly, four individual models were by ANFIS. In these models;

- Model 1: Relation of the number of codes and the number of learning outcomes for reading and listening skills with PISA score,
- Model 2: Relation of the number of codes and the number of learning outcomes for reading and speaking skills with PISA score,
- Model 3: Relation of the number of codes and the number of learning outcomes for reading and writing skills with PISA score,
- Model 4: Relation of the number of codes and the number of learning outcomes for reading, listening, speaking and writing skills with PISA score, were examined.

The root mean square error (RMSE) and the coefficient of determination (R2) for the four models developed were demonstrated in table 7:

Table 7: RMSE and R2 values of models

Model number	**RMSE**	**R2**
Model 1	20,5737	0,780652
Model 2	13,5731	0,851708
Model 3	8,7802	0,844698
Model 4	17,3951	0,683623

The results of the ANFIS analysis by using the data obtained from the native language programs of the countries covered within the scope of the research were illustrated in the figures below.

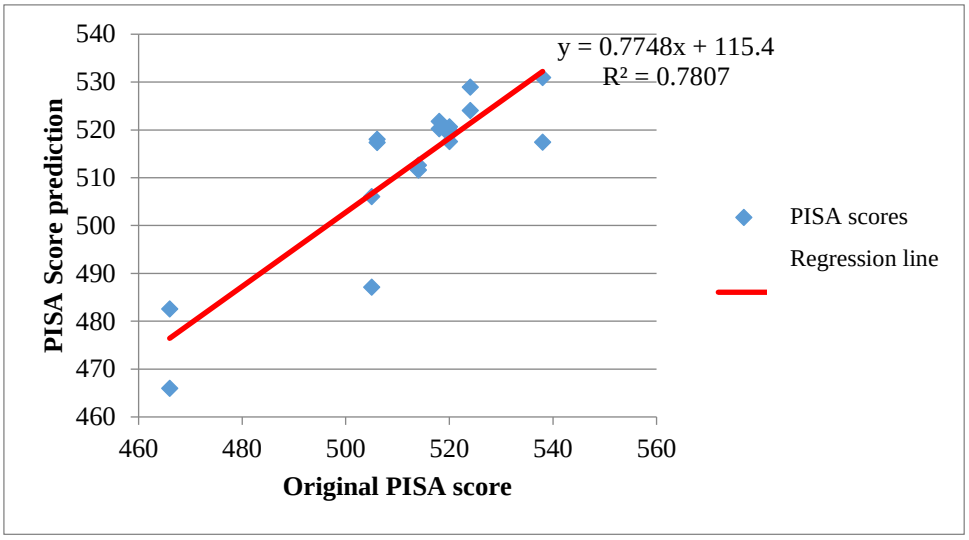


Figure 1: Relation of the number of codes and the number of learning outcomes for reading and listening skills with PISA score

As can be seen in Figure 1 for model 1, the R2 was 0.78 in the relationship of the number of codes and learning outcomes obtained from reading and listening skills in native language programs of countries with PISA scores. A significant relationship was found between them (linguistic value equivalents of statistical values: 40: insufficient; 55-70: average; 70-80: very good; 80 and above: Superior; Taylan & Karagözoğlu, 2009; significance: Darman et al., 2019). The RMSE value is 20.5737.

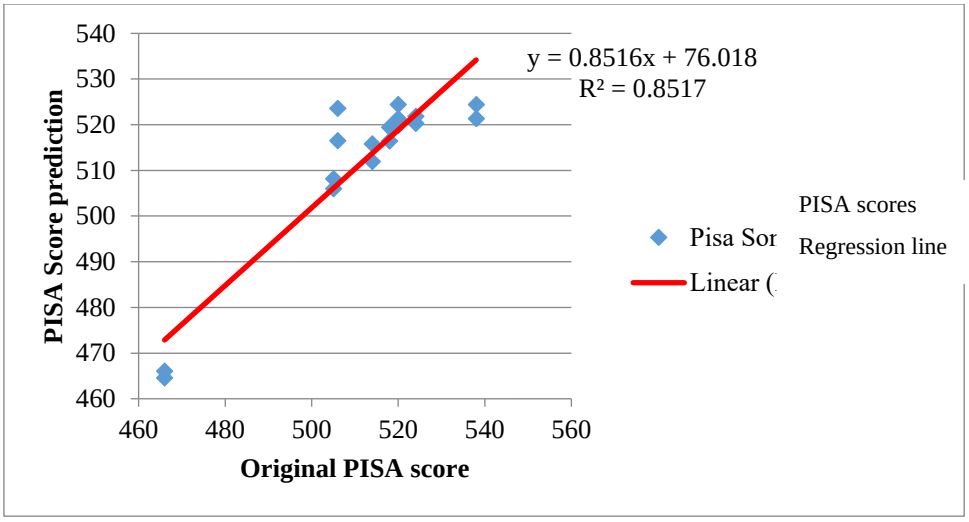


Figure 2: Relation of the number of codes and the number of learning outcomes for reading and speaking skills with PISA score

Figure 2 for model 2 showed that the R2 was 0.85 in the relationship of the number of codes and learning outcomes obtained from reading and speaking skills in native language programs of countries with PISA scores. There was a significant relationship between them. The RMSE value was 13.5731.

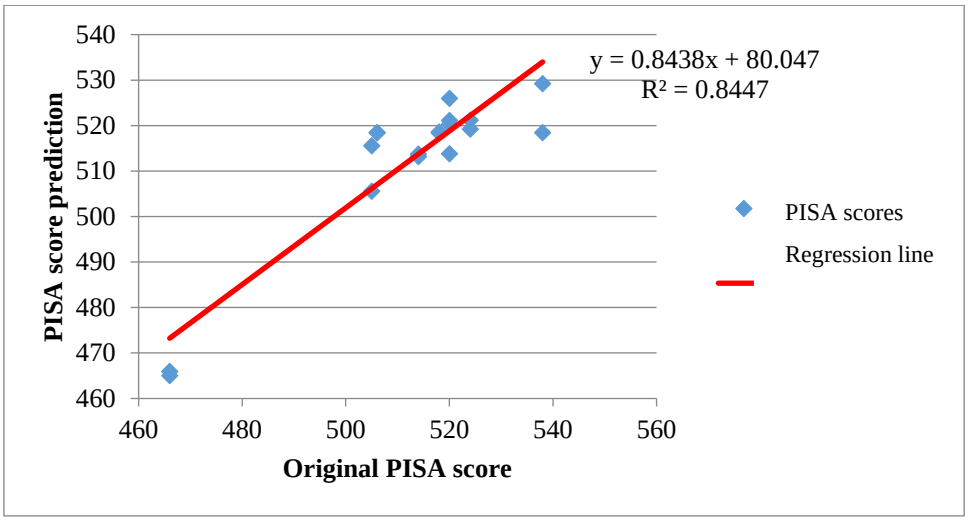


Figure 3: Relation of the number of codes and the number of learning outcomes for reading and writing skills with PISA score

As can be seen in Figure 3 of model 3, the R2 was 0.84 in the relationship of the number of codes and learning outcomes obtained from reading and writing skills in native language

programs of countries with PISA scores. A significant relationship was found between them. The RMSE value was 8,7802.

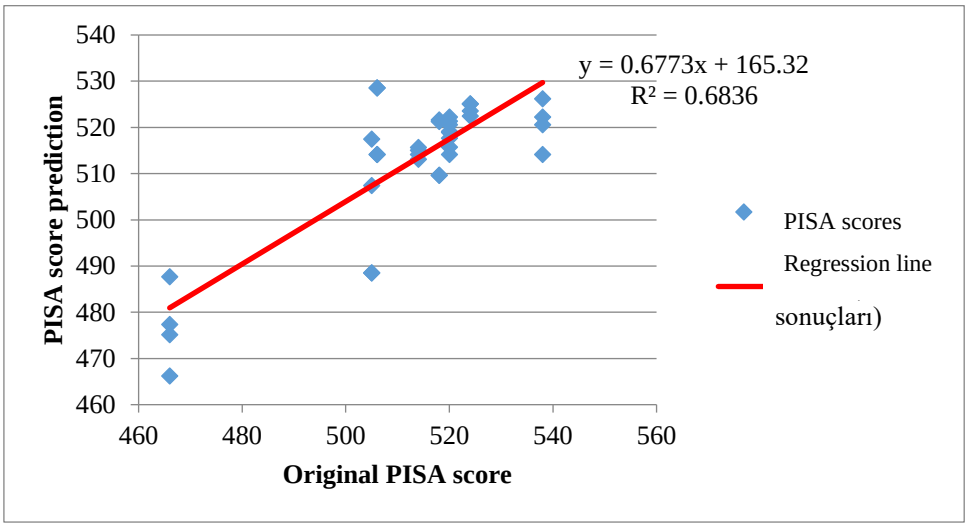


Figure 4: Relation of the number of codes and the number of learning outcomes for reading, listening, speaking and writing skills with PISA score

Figure 4 of model four shows that the R2 was 0.68 in the relationship of the number of codes and learning outcomes obtained from reading, listening, speaking and writing skills in native language programs of countries with PISA scores. A significant relationship was found between them. The RMSE value was 17.3951.

Although there is no study in the literature to be parallel or similar to the results of the research, there are some studies in which ANFIS analysis is used or which is involved with Educational Sciences. Vasileva-Stojanovska et al. (2015) introduced ANFIS model for students in a blended learning environment that uses technology-enriched classes, including video conferencing events and video streaming lessons, in their research named 'ANFIS model of experience quality estimation in education'. The research shows that the person is influenced by subjective factors determined by personality traits and learning style. R2 value was found to be 0.8244 in ANFIS-based estimate.

Hidayah, Permanasari, and Ratwastuti (2013) applied the same method to classify students in the undergraduate program in the Department of Electrical Engineering and Information Technology, Gadjah Mada University. In addition, many studies have been conducted on Intelligent Tutoring Systems and e-learning systems, and a student classification model has been developed with ANFIS. The Model was used to predict students ' academic

performance, and the research showed that the combination of three parameter values-interest, ability, and motivation-is the best model for student classification. The RMSE value is 0.25611.

Al-Hmouz et al. (2011) found that ANFIS is effective in hybrid learning to adapt learning content to students' needs. The study results show that ANFIS has been successfully applied to adapt learning content within different learning. The research is based on an analysis of different model settings and confirms that the m-learning application is functional. Tosunoğlu (2017) examined the effect of success in statistics on students' attitudes towards statistics using ANFIS. The model created by ANFIS showed that the attitudes of students who received low grades of achievement in statistics were negative, and that attitude was more positive as success increased. This study also revealed the successful use of fuzzy methods in the Social Sciences.

5.0 CONCLUSION

In models created for use in ANFIS analysis, the number of learning outcomes and the number of codes in each country's language skills were demonstrated in the tables. The following conclusions were reached when the number of codes and the number of learning outcomes obtained from the language skills content in the native language programs of the countries covered by the study and the 2018 PISA scores were examined:

i) Canada and Turkey had the highest number of learning outcomes in reading skills. Although the country with the minimum number of learning outcomes was Singapore, it was also ranked the highest in the PISA score list. The maximum number of learning outcomes in listening skills was in South Korea, with 53. This number was followed by Turkey, which had of learning outcomes was 52.

ii) The highest number of codes in reading skills was in the United States, with 70 learning outcomes, while the highest number of codes in listening skills was in Canada, with 44 learning outcomes. The maximum number of learning outcomes in speaking skills was in South Korea, with 57, while the minimum was in Sweden, with 4. Although the reading skill values were the same, the maximum number of codes in speaking skills was in Canada, with 8. The maximum number of learning outcomes in writing skills was in Canada, with 100. After Finland, the minimum number of learning outcomes, as in Singapore and Sweden, is 13. The maximum number of code in writing skills was in Hong Kong, South Korea, İreland, Canada and The United States, with 6. This number was followed by Singapore and Sweden with 4.

Accordingly, the number of learning outcomes in all language skills generally does not affect the success of PISA (example of Singapore with its permanent success and Sweden raised in ranking). The country with the highest number of learning outcomes in reading skills was Turkey, which has the lowest score among these countries. Four models created for ANFIS analysis that were:

i) Relation of the number of codes and the number of learning outcomes for reading and listening to PISA score,
ii) Relation of the number of codes and the number of learning outcomes for reading and speaking to PISA score,
iii) Relation of the number of codes and the number of learning outcomes for reading and writing to PISA score,
iv) Relation of the number of codes and the number of learning outcomes for reading, listening, speaking and writing to PISA score, were created as a result of ANFIS analysis conducted in the context of the relationship between the number of codes and achievements obtained from native language education programs of countries with PISA scores.

The RMSE and R2 values of the models are: RMSE 20.5737, R2 0.780652 for model 1; RMSE 13.5731, R2 0.851708 for model 2; RMSE 8,7902, R2 0.844698 for model 3; RMSE 17, 3951, R2 0.683623 for model 4.

In model 1, where the number of codes and the number of learning outcomes for reading and listening skills were related to the PISA score, the RMSE value was 20.5737, and the coefficient of determination value was 0.78. The relationship between them was decidedly significant (linguistic value equivalents of statistical values: 40: insufficient; 55-70: average; 70-80: very good; 80 and above: superior; Taylan & Karagözoğlu, 2009; significance: Darman et al., 2019). It can concluded that listening skills, as well as reading ability in the native language curriculum of countries, were moderately related to PISA scores that stand out from reading ability. In model 2, which is related to the number of codes and the number of learning outcomes for reading and speaking skills with PISA score, the RMSE value was 13.5731 and the coefficient of determination value was 0.85. The relationship between them is decidedly meaningful. It was concluded that besides the reading skills included in the native language curriculum of the countries, speaking skills have a strong influence on the PISA scores that came to the fore with reading skills. In model 3, the RMSE value was 8,7802 and the coefficient of determination was 0.84, which is related to the number of codes and the number of learning

outcomes for reading and writing skills with PISA score. The relationship between them is decidedly meaningful. It was concluded that besides the reading skills included in the native language curriculum of the countries, writing skills were superior to the PISA scores that came to the fore with reading skills. In model 4, which is related to the number of codes and learning outcomes for reading, listening, speaking and writing skills with PISA score, the RMSE value was 17.3951, and the coefficient of determination was 0.68. The relationship between them was insufficiently meaningful. It was concluded that listening, speaking and writing skills, as well as reading skills included in the native language curriculum of countries, were poorly related to PISA scores that came to the fore with reading skills.

It could be concluded that the speaking and writing skills included in model 2 (0.85 coefficient of determination) and model 3 (0.84 coefficient of determination) were much more effective in their relationship with the PISA score than the integrated language skills, which are all listening, speaking, reading and writing skills. When we look at language skills, the number of codes, and the number of learning outcomes found in their native language programs with PISA scores of countries, the least relationship is observed between integrated skills and reading and listening skills. Considering that language skills are integrated, the relationship between listening, speaking and writing skills with reading skills was evaluated with PISA scores and the following results were reached: The relationship between reading and listening was found to be 'very good', the relationship between reading and speaking was found to be 'very good', the relationship between reading and writing was found to be 'very good' and the relationship between reading, listening, speaking and writing was found to be 'average'. It has been observed that using all language skills for success in reading has reduced the value of the relationship.

The fact that all countries except Turkey are united at some point in the line in the charts shows that their success scores and program content match. In the charts, the fact that Turkey is far from the line in each model shows that it is outside the associated group. The close distribution of other countries along the chart line indicates that the program content of those countries matches. This research was carried out with countries that have consistently achieved success and countries whose ranking has increased in the last three years' PISA. For this purpose, it covers the native language curriculum of nine countries and the Turkish curriculum. Only one program in the countries with more than one native language program was examined, and the current programs in the countries covered by the research were taken as a sample. In this context, expanding the number of countries and their native language programs can guide future research.

In addition, we see the traces of the use of artificial intelligence in education with developments in emerging technologies and science, especially when concluding the ambiguous data that we encounter in the Social Sciences. ANFIS, a statistical technique based on artificial intelligence methods, which we are gradually observing its use in international literature, was used in this research. Different artificial intelligence techniques like ANFIS would make existing research more comprehensive. ANFIS method can be used not only to design native language curricula or to see the relationship of programs with an international PISA score but also to evaluate or improve national exams.

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