THE EXAMINATION OF VARIABLES EXPLAINING MATHEMATICS LITERACY BY CHAID ANALYSIS: PISA 2018 TURKEY

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ABSTRACT

This study aims to investigate the variables explaining mathematics literacy of Turkish students who attended at Programme for International Student Assessment (PISA). The topic of the study is at utmost importance due to the potential findings that will identify the variables influencing mathematical literacy in our education system and generate recommendations aimed at addressing shortcomings.This study utilizes the answers given to the PISA student questionnaire, which are analysed by correlational survey design.Stratified sampling design is used in the selection of 6890 students in Turkish sample. After excluding the missing data, the sample of the study consists of 5293 participants. Chi-squared Automatic Interaction Detection (CHAID) method, which is one of the data mining decision tree algorithms, is used for data analysis. According to the results of the study, the most important variable explaining Turkish students' mathematic literacy is the number of the books at home. Father's education level, highest parental education level, accessibility of ICT both at home and school, and time allocated per week to study mathematics are other variables explaining mathematics literacy.

Keywords: PISA, Mathematics Literacy, Data Mining, CHAID Analysis.

PISA 2018 TÜRKİYE MATEMATİK OKURYAZARLIĞINI AÇIKLAYAN DEĞİŞKENLERİN CHAID ANALİZİ İLE İNCELENMESİ

ÖZET

Bu çalışmanın amacı, Türk öğrencilerin Uluslararası Öğrenci Değerlendirme Programı (PISA) 2018 öğrenci anketine verdikleri yanıtlarla matematik okuryazarlığını açıklayan değişkenleri incelemektir. Çalışmanın konusu, eğitim sisteminde tespit edilecek eksikliklerin giderilerek gerekli önlemlerin alınabilmesi için bulgular sağlayacak olması yönüyle önemlidir. İlişkisel tarama modelinde gerçekleştirilen araştırmanın Türkiye örneklemini tabakalı örnekleme deseniyle seçilen 6890 öğrenci oluşturmaktadır. Araştırmanın örneklemini eksik değerleri içeren veriler çıkarıldıktan sonra kalan 5293 kişi oluşturmaktadır. Bu çalışmada veri analizi için veri madenciliği karar ağacı algoritmalarından biri olan Ki-kare Otomatik Etkileşim Tespiti (CHAID) yöntemi kullanılmıştır. Analiz sonucunda Türk öğrencilerin matematik okuryazarlığını en iyi açıklayan değişkenin "evdeki kitap sayısı" olduğu sonucuna ulaşılmıştır. Öğrencilerin Baba Eğitim Düzeyi, En Yüksek Ebeveyn Eğitim Seviyesi, Okulda ve Evde BİT Erişebilirliği, Matematik Dersi için Haftada Ayrılan Öğrenme Zamanı da matematik okuryazarlığını açıklayan diğer değişkenler olarak bulunmuştur.

Anahtar Kelimeler: PISA, Matematik Okuryazarlığı, Veri Madenciliği, CHAID Analizi.

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1. INTRODUCTION

PISA is an international study conducted by the OECD to assess the mathematical, scientific and reading literacy of students continuing their education at the age of 15. PISA is conducted every three years, with each cycle focusing on one of the three areas of mathematical literacy, scientific literacy and reading literacy. The weighted domain of the most recent PISA, conducted in 2018, is reading literacy. 41 countries participated in the PISA application in 2003, 57 countries in 2006, 65 countries in 2009 and 2012, 72 countries in 2015, and 79 countries in 2018, with Turkey participating since 2003 (MoNE, 2018).

In PISA, reading skill pertains understanding, using, evaluating, retrospecting on, and associating with the reading text rather than being interested in students' basic reading skills (OECD, 2019b). Science literacy is defined by three proficiency areas. These proficiency areas are explaining scientific phenomena, designing and evaluating a scientific research, and interpreting the data and evidences scientifically. Mathematical literacy focuses on the necessity to develop students' ability to utilize mathematics in daily contexts. Increasing the number of learning experiences in mathematics classes is also essential for enhancing students' capacities in this field (OECD, 2019a). The foundation of mathematical literacy in PISA lies in active engagement with mathematics. Engaging in mathematical reasoning involves using mathematical concepts, procedures, facts, and tools to predict and explain phenomena. In particular, the verbs "formulating," "utilizing," and "interpreting" signify three processes where students actively engage as problem solvers. The content of the curriculum includes situations familiar to students, such as cooking, shopping, or watching sports events, alongside questions related to professional, societal, and scientific contexts, such as calculating the cost of a project, interpreting national statistics, or modelling natural phenomena. The mathematics proficiency defined within the scope of the PISA research assists individuals in recognizing the role of mathematics in the world and aids in making informed decisions (OECD, 2019a). The mathematics literacy defined in this manner encompasses far more than the ability to simply reproduce mathematical concepts and operations learned in school. This approach to mathematical literacy supports students in developing a strong understanding of mathematical concepts and encourages exploration in the abstract world of mathematics. PISA aims to measure how well students can derive meaning from what they know and how effectively they can use mathematical knowledge in new situations. With this objective in mind, the mathematical subtest used in PISA focuses on real-life situations where mathematical skills are employed. These questions also reflect scenarios in which individuals might use mathematical tools such as calculators or rulers when solving everyday problems (OECD, 2019b). The assessment framework for mathematical literacy was updated PISA's 2012 implementation and was utilized in the 2015 and 2018 PISA assessments. This framework reflects a broad spectrum of mathematical applications, ranging from daily personal use to the scientific demands of global issues.

In comparison with the PISA 2015 results, Turkey's PISA 2018 outcomes exhibited a substantial increase in average scores across all three areas: reading proficiency increased by 38 points to 466, mathematical literacy by 34 points to 454, and scientific literacy by 43 points to 468 (MoNe, 2018) Notably, Turkey was one of three countries among the OECD nations that significantly raised their scores in all three domains. Despite an increase in the number of participating countries in PISA 2018 (79 countries), Turkey managed to elevate its ranking in mathematics from 50th to 42nd place, marking the most significant score improvement compared to PISA 2015. Within the OECD countries, Turkey ranked 33rd among 37 nations.

Analyses of studies investigating PISA mathematical literacy and its associated predictive and explanatory variables revealed in the study by Akyüz and Satıcı (2012) that the most substantial impact on mathematical literacy was attributed to the implicit variable of school belonging. In the study by Aksu and

Güzeller (2012), it was concluded that to change student achievement in mathematical literacy within the Turkish sample, special emphasis should be placed on self-efficacy perception, attitudes towards the subject, anxiety levels, and the aspect of study discipline. In his study, Demir (2015) expressed that among latent variables, problem-solving behaviours emerged as the best predictor of mathematical literacy skills. Within the observed variables, the most significant predictors were identified as "persistence in problem-solving," "mathematics anxiety," and "openness to problem-solving". In Koğar's (2015) study, it was concluded that the variable most significantly explaining mathematical literacy is mathematical self-efficacy. In the study conducted by Şahin and Yıldırım (2016), it was signified that mathematical self-efficacy emerged as the strongest predictor of the variable for mathematical literacy, while mathematical interest was identified as the primary predictor of mathematical behavioural change. They further noted that mathematical self-efficacy significantly influences the prediction of mathematical literacy, and mathematical interest has a notably substantial positive impact on predicting mathematical behaviour. According to Aksu, Güzeller, and Eser (2017), gender, school type, motivation, self-efficacy, attitudes, behavior control, reasons for failure, study discipline, parental education, computer ownership, age, and tablet ownership were found to be the statistically significant predictors among student-level predictors. On the other hand, at the school level, it was determined that variables such as school income, the number of mathematics teachers in the school, total student enrolment, the teacher-student ratio in the school, and the teacher's morale have a meaningful impact on predicting mathematical literacy. Mutluer and Büyükkıdık (2017) indicated in their study that in the classification of mathematical literacy, parental education level, enjoyment derived from mathematics, self-perception of mathematical ability/quick learning, and perseverance - quick surrender demonstrated a significant impact as independent variables. When assessing the analysis methods applied in research on mathematical literacy, it is seen that numerous studies have utilized various statistical techniques including t-tests, ANOVA, correlation analysis, structural equation modelling, cluster analysis, and logistic regression analysis. However, each of these analyses has certain requirements that need to be met, such as handling missing data, outliers, multicollinearity issues, assumptions of normality, linearity, and homogeneity. Therefore, the conducted studies may include only a limited number of variables available in the surveys within the PISA due to the requirements and constraints associated with the specific analysis techniques. However, in comprehensive assessments like PISA, where countries can position themselves by comparing with other nations and evaluate educational system outputs, conducting extensive studies on each variable present in such assessments becomes critically important. Thus, recently, decision trees and data mining techniques has become more prevalent to analyze extensive datasets like PISA in order to be analysed with techniques that are less demanding (Silahtaroğlu, 2013).

Decision trees are a data analysis method that dissects input data into subgroups resembling the branching of a tree, using a classification or clustering algorithm to reveal factors affecting the target variable (dependent variable) and their historical relationships until all elements belong to the same class label (Kayri, 2014). To make classification in decision trees, an appropriate tree model is created based on the available data. The dataset is then applied to this model, and the resulting outcome determines the classification. When the dataset is correctly segmented, the resulting groups tend to exhibit similar contents within each group. Decision trees involve the process of dividing vast amount of data into homogenous sub-groups based on target variable by using decision- making rules (Berry & Linoff, 2004). Decision trees are an analysis method that does not require meeting assumptions like normality, linearity, and homogeneity (Horner et al., 2010). They allow the simultaneous inclusion of numerous categorical and continuous independent variables in the analysis. One of the most commonly used decision tree algorithms is the CHAID (Chi-squared Automatic Interaction Detection) algorithm. CHAID is an analytical method used to classify the variables that are included in the analysis. The

CHAID method, an effective classification technique, utilizes the chi-squared statistic to determine the most appropriate division on the dataset (Chang, 2011). The CHAID analysis divides the dataset of categorical variables and the dependent variable into detailed, homogeneous subgroups, aiming to best explain the data. The step-by-step process of merging similar categories continues until a statistical decision is reached that no further amalgamation can be made among the variables (Doğan, 2003). If the target variable used is continuous, the F-statistic is utilized; if it is categorical, the Chi-square statistic is employed (Oğuzlar, 2004). In this context, the problem of the current study is identifying the variables that explain the mathematical literacy in PISA 2018 by utilizing CHAID analysis, which provides the opportunity for analysis without requiring various prerequisites. The topic of the study is at utmost importance due to the potential findings that will identify the variables influencing mathematical literacy in our education system and generate recommendations aimed at addressing shortcomings.

The aim of the study is to examine the variables that explain mathematics literacy by analysing students' responses to questionnaire in the PISA 2018 sample from Turkey. The research problems to be investigated within this scope are as follows:

1. What independent variable in the PISA 2018 Turkey sample best explains mathematical literacy and segments the dataset into homogeneous subgroups?
2. In the PISA 2018 Turkey sample, which variables sequentially explain mathematical literacy and segment the data into homogeneous subgroups?
3. In the PISA 2018 Turkey sample, what is the hierarchy of importance among independent variables in classifying students in terms of mathematical literacy?

2. METHODOLOGY

This research, aiming at examining the variables explaining the mathematical literacy of Turkish students based on PISA 2018 data, was conducted using a correlational survey design. The correlational survey design encompasses studies that provide insights into the relationship between variables within a group and the probability of cause-effect relationships among variables (Fraenkel et al., 2012).

Population and Sample

Turkey participated in PISA 2018 with 186 schools and 6890 students representing 12 regions that are in Nomenclature of Territorial Units for Statistics (NTUS) Level 1.The selection of students in the sample was carried out randomly (probability-based) by the International Center to represent 15-year-old students in Turkey. 43.7% of the 15-year old students represented in PISA 2018 attend Anatolian high schools, 31.1% attend Vocational and Technical Anatolian high schools, and 13.7% attend Anatolian Imam Hatip High Schools. Students enrolled in Science High Schools, Social Sciences High Schools, Multi-Program Anatolian High Schools, and Anatolian Fine Arts High Schools comprise 11.2% of the PISA 2018 Turkey sample. 0.3% of the students in the target group are continuing their education at the middle school level. 49.6% of the sample in Turkey consists of female students, while 50.4% comprises male students. The sample in Turkey demonstrates a fairly balanced distribution in terms of gender groups. Upon examining the distribution of students by grade level in the sample, it was seen that 78.8% of the students are in the 10th grade, 17.7% in the 9th grade, and 2.9% in the 11th grade. The total proportion of students in the other grade levels is below 1% (MoNE, 2018).

The data belonging to 6,890 participants, intended for use in the research, was obtained by downloading from the official PISA website. Subsequently, investigations concerning missing values were conducted, and after removing the missing values from the dataset, the analysis was carried out on a total study group of 5,293 participants.

Data Collection Instruments

In the scope of the research, the PISA 2018 student questionnaires were employed as the data collection instrument. The identification of variables explaining mathematical literacy was supported by existing studies in the literature (Gursakal, 2012; Kogar, 2015; Martins & Veiga, 2010; Mutluer & Buyukkıdık, 2017; Liu et al., 2023). The selected items and indices from the PISA 2018 student questionnaire are presented in Table 1.

Table 1. Variables Used in the Research on Mathematical Literacy

Items and Indices	Explanation
ST013Q01TA	Number of Books in the House
MISCED	Education Level of Mother
FISCED	Education Level of Father
HISCED	Highest Education Level of Parents
MMINS	Time Allocated per Week for Mathematics Lessons
TMINS	Weekly Study Time
ESCS	Economic, Social, and Cultural Index
ICTHOME	Level of Access to ICT (Information and Communication Technologies) at Home
ICTSCH	Level of Access to ICT at School
HEDRES	Educational Resources at Home
ICTRES	ICT Resources
JOYREAD	Joy for Reading
ATTLNACT	Attitude Toward School: Learning Activities
GFOFAIL	General Fear of Fail
BELONG	Subjective Well-being: Sense of Belonging to School
HOMESCH	Use of ITC outside of the School (for School Work)
USESCH	Overall Use of ICT in School
COMPICT	ICT Competence
AUTICT	Individual ICT Use
ICTCLASS	Use of ICT in the Class for Subject-related Activities

The Analysis of the Data

Prior to commencing the analysis of the data in the research, investigations were conducted on the existence of missing values. To avoid the bias due to the systematic differences between respondents and non-respondents, missing data was removed from the dataset.

In this study, the average mathematical literacy score was obtained by averaging 10 different math scores coded as PVMATH in the PISA 2018 data (Brown & Micklewright, 2004). Subsequently, the average of the achieved scores ($\bar{x}$=452.61) was determined, and this value was set as the cut-off point. Those above the average were categorized as 2 in terms of achievement, while those below the average were categorized as 1.

Students with mathematical literacy scores below the specified value were categorized as 'unsuccessful,' while those equal to or above the average in mathematical literacy were categorized as 'successful. Then, data mining CHAID analysis was utilized in the SPSS program to conduct analyses.

3. RESULTS

The purpose of the study is to determine the most influential variable affecting the success of students in PISA 2018 Turkey sample on mathematics literacy and to examine the order of importance of independent variables' effect on the dependent variable in detail by using CHAID, which is one of the decision tree methods. It is also aimed to reveal to the data related to the frequency and percentage values of the classifications of independent variables and when this classification will end. As a result of CHAID analysis, the table regarding the correct classification of successful and unsuccessful students is provided. The data related to the classification is illustrated in Table 2.

Table 2. Confusion Matrix

Observed	Predicted		
	Unsuccessful	Successful	Correct Classification Percentage
Unsuccessful	1573	778	66,9%
Successful	859	2083	70,8%
Total Percentage	45,9%	54,1%	69,1%

As it is seen in Table 2, out of 2351 students classified as unsuccessful, 1573 (67%) were correctly classified in the model, whereas 778 students (33%) who were unsuccessful were incorrectly classified as successful. Likewise, out of 2942 successful students, 2083 (71%) were correctly classified in the model, whereas 859 students (29%) who were successful were incorrectly classified as unsuccessful. The table shows that the overall success rate of the program in classifying successful and unsuccessful students is 69.1%. In addition to the program's classification table, an error margin at the level of the given risk is also provided. In this line, the system's risk value is determined approximately as 31%. Analysis results regarding which variables are determinant in classifying students as successful or unsuccessful based on mathematical literacy scores and their rank of importance are shown in Figure 1.

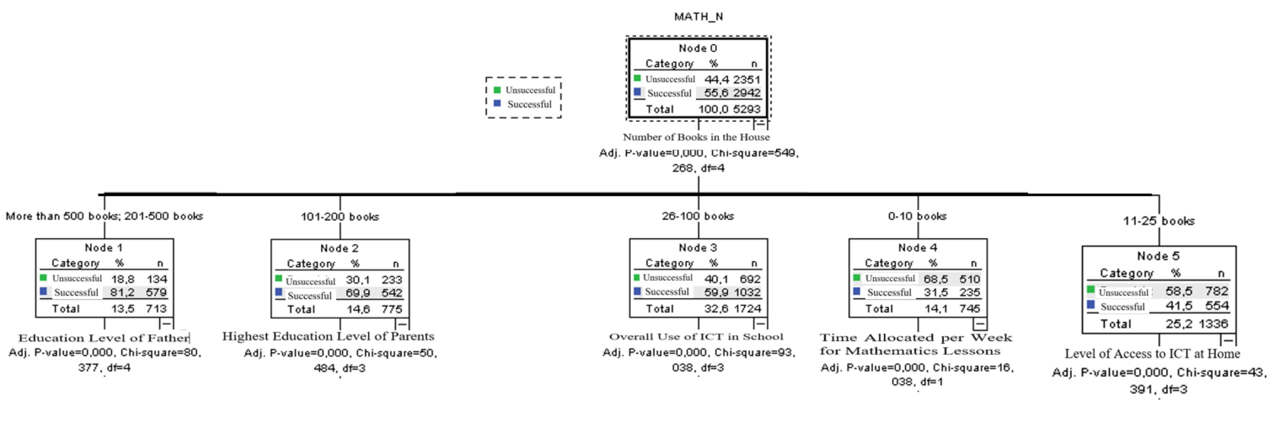

Figure 1. The Initial Node Formed as a Result of CHAID Analysis (Node 0)

The initial nodes formed as a result of CHAID analysis is given in Figure 1. 5293 students participated in the study. The figure shows that 44.4% of the students (2351) are classified as unsuccessful, while 55.6% (2942) are classified as successful. According to the results of the CHAID analysis, it is seen that the variable "number of books at home" from the student survey best explains students' mathematical literacy ($\chi 2$=549.29, p=.000). According to this variable, a significant differentiation between students' success statuses is found and five branching points are determined at the starting node. It is seen that students who has “201 or more” books in their houses gather in Node 1, and among these 714 students, 579 of them are classified as successful and 134 of them are classified as unsuccessful. The students within this group constitute 13.5% of the entire dataset, and it is found that the majority of these students (81.2%) are successful. It is seen that students who has “101-200” books in their houses gather in Node 2, and among these 775 students, 542 of them are classified as successful and 233 of them are classified as unsuccessful. The students within this group account for 14.6% of the entire dataset, and it is revealed that the majority of these students (69.9%) are successful. Students possessing "26-100" books at their residence gathered at Node 3, where 1724 students in this group are observed, with 1032 classified as successful and 692 as unsuccessful. This group constitutes 32.6% of the entire dataset, and it is revealed that the majority of these students (59.9%) have achieved success. Students with "0-10" books at home gather at Node 4, wherein 745 students in this group are observed, with 235 classified as successful and 510 as unsuccessful. This group constitutes 14.1% of the entire dataset, and it is found that the majority of these students (68.5%) are unsuccessful. Additionally, students with "11-25" books at their residence gather at Node 5, where 1336 students in this group are observed, with 554 classified as successful and 782 as unsuccessful. This group constitutes 25.2% of the entire dataset, and it is uncovered that the majority of these students (58.5%) are unsuccessful. It can be concluded that as the number of books at their homes increases, students significantly tend to be more successful.

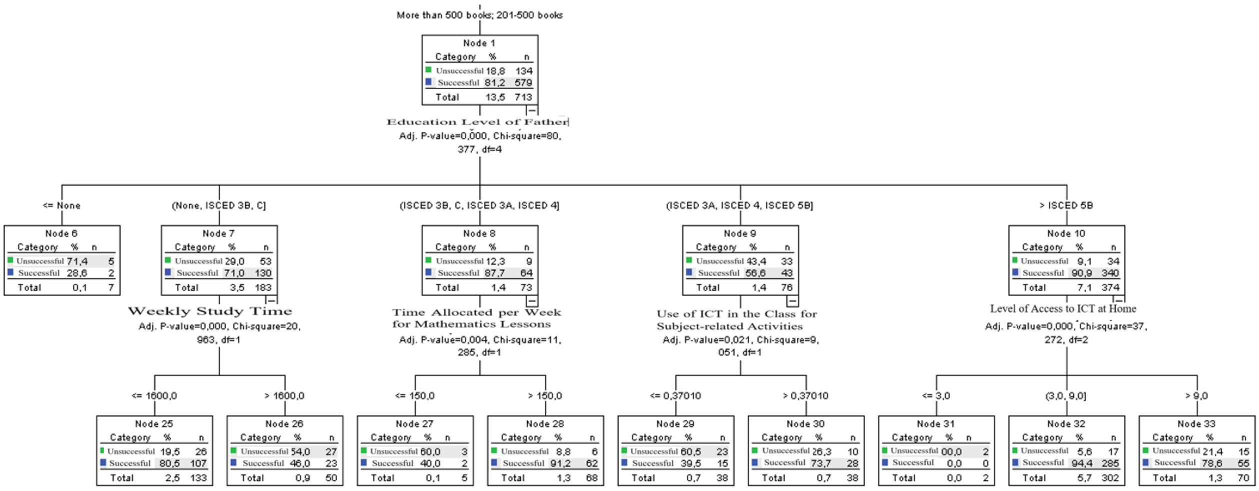

Figure 2. The First Node Formed as a Result of CHAID Analysis (Node 1)

For students with more than 201 books at home, the variable that best explains their mathematical literacy is found to be the "Education Level of Father" (χ^2=80.38, p=.000). According to this variable, a significant difference among students' success statuses is identified, resulting in five branches at the first node.

Students with unidentified "Education Level of Father" are observed to gather at Node 6, where 7 students in this group are seen, with 2 classified as successful and 5 as unsuccessful. This group constitutes 0.1% of the dataset. This node has been completed without any further branching.

Students with fathers whose education level is not defined or who completed distance learning or vocational training, are observed to gather at Node 7. Among this group of 183 students, 130 are classified as successful, and 50 are categorized as unsuccessful. These students constitute 3.5% of the dataset, and it is seen that the majority of them (71%) are successful. Within this node, the determinative variable for a sub-branching was found to be the "Weekly Study Time" which resulted in the creation of two distinct sub-branching points: students dedicating equal to or less than 1600 minutes per week to learning, and those dedicating more than 1600 minutes. These sub-branches conclude the respective paths. Students dedicating equal to or less than 1600 minutes per week to learning, they congregate at Node 25. This node consists of 133 students, with 107 classified as successful and 26 as unsuccessful. This group represents 2.5% of the dataset, and it has been established that the majority (80.5%) are successful. Conversely, students dedicating more than 1600 minutes per week to learning assemble at Node 26, consisting of 50 students, with 23 classified as successful and 27 as unsuccessful. This group represents 0.9% of the dataset, and it has been determined that the majority (54%) are unsuccessful. It has been observed that as the time dedicated to weekly learning decreases below 1600 minutes, students significantly become more successful.

Students with “Education Level of Father” described as distance learning, open high school, and vocational training education accumulate at Node 8. Within this group of 73 students, 64 are classified as successful, while 9 are categorized as unsuccessful. These students represent 1.4% of the dataset, and it has been established that the vast majority (87.7%) are successful. In this node, the determining variable for a sub-branching was found to be the "Time Allocated per for Mathematics Lessons," resulting in the creation of two distinct branching points: students devoting equal to or less than 150 minutes per week to mathematics learning, and those dedicating more than 150 minutes. These sub-branches conclude the respective paths. For students devoting equal to or less than 150 minutes per week to mathematics learning, they congregate at Node 27, comprising 5 students, with 2 classified as successful and 3 as unsuccessful. This group represents 0.1% of the dataset. Conversely, students devoting more than 150 minutes per week to mathematics learning assemble at Node 28, consisting of 68 students, with 62 classified as successful and 6 as unsuccessful. This group represents 1.3% of the dataset, and it has been determined that the vast majority (91.2%) are successful. It has been observed that as the time dedicated to weekly learning for mathematics exceeds 150 minutes, students significantly become more successful.

Students described as having fathers who completed open high school and distance education congregate at Node 9. Within this group of 76 students, 43 are classified as successful, while 33 are categorized as unsuccessful. These students represent 1.4% of the dataset, and it has been determined that the majority (56.6%) are successful. In this node, the determining variable for a sub-branching was found to be the "Use of ICT in the Class for Subject-related Activities," resulting in the creation of two distinct branching points: students utilizing equal to or less than 0.37 regarding Use of ICT in the Class for Subject-related Activities, and those utilizing more than 0.37. These sub-branches conclude the respective paths. For students utilizing equal to or less than 0.37 of Information Technologies during class related to the subject, they congregate at Node 29, comprising 38 students, with 15 classified as successful and 23 as unsuccessful. This group represents 0.7% of the dataset, and it has been determined that the majority (60.5%) are unsuccessful. Conversely, students utilizing more than 0.37 of Information Technologies during class related to the subject assemble at Node 30, consisting of 38 students, with 28 classified as successful and 10 as unsuccessful. This group represents 0.7% of the dataset, and it has been determined that the majority (73.7%) are successful. It has been observed that as the use of Information Technologies related to the subject during class exceeds 0.37, students significantly become more successful.Students identified with "Education Level of Father" as having completed distance learning and university education congregate at Node 10. Within this group of 374 students, 340 are classified as successful, while 34 are categorized as unsuccessful. These students represent 7.1% of the dataset, and it has been determined that the majority (90.9%) are successful. In this node, the determining variable for a sub-branching was found to be the "Level of Access to ICT at Home," resulting in the creation of three distinct branching points: students with access to Information Technologies equal to or less than 3, between 3 and 9 (inclusive), and more than 9 at home. These sub-branches conclude the respective paths. For students with access to ICT equal to or less than 3 at home, they congregate at Node 31, comprising 2 students, both classified as unsuccessful. For students with access to ICT between 3 and 9 at home, they congregate at Node 32, consisting of 302 students, with 295 classified as successful and 17 as unsuccessful. This group represents 5.7% of the dataset, and it has been determined that the majority (94.4%) are successful. Finally, for students with a level of access to ICT at home higher than 9, they assemble at Node 33, consisting of 70 students, with 55 classified as successful and 15 as unsuccessful. This group represents 1.3% of the dataset, and it has been determined that the majority (78.6%) are successful.

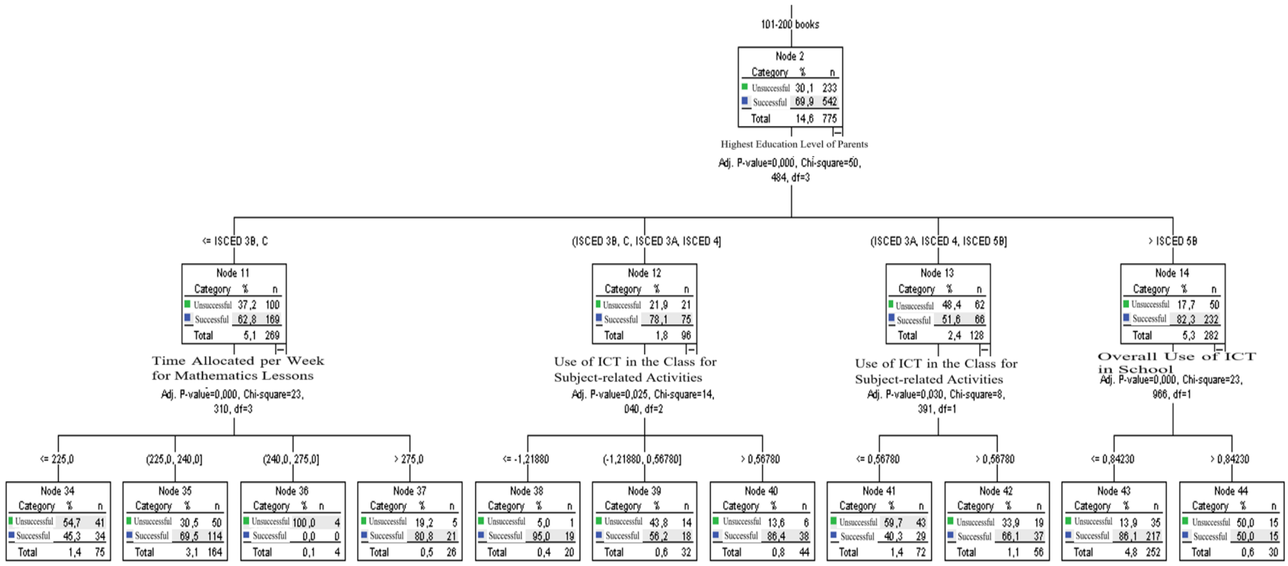

Figure 3. The Second Node Formed as a Result of CHAID Analysis (Node 2)

Students with "101-200" books at home have been identified to have "Highest Education Level of Parents" as the variable that best explains their mathematical literacy ($\chi 2=50.48$, p=.000). According to this variable, a significant differentiation among students' success statuses has been identified, resulting in four branches at the second node.

It is seen that students, whose parents' education level is equal to or lower than open high school and vocational high school, gather in Node 11 and among 269 students in this group, 169 of them are classified as successful and 100 of them are classified as unsuccessful. The students within this group constitute 5.1% of the dataset, and it has been determined that the majority of these students (62.8%) are successful. In this node, the determining variable for a sub-branching was identified as the 'Time Allocated per Week for Mathematics Lessons.' This resulted in the establishment of four distinct branching points: dedicating equal to or less than 225 minutes, between 225-240 minutes (including 240), between 240-275 minutes (including 275), and more than 275 minutes per week for learning mathematics. Students allocating equal to or less than 225 minutes per week for learning mathematics congregate at Node 34, and it is found that among 75 students in this group, 34 students are classified as successful and 41 students are classified as unsuccessful. The students within this group represent 1.4% of the entire dataset, and it is indicated that the majority of these students (54.7%) are unsuccessful. Students allocating between 225 and 240 minutes per week for learning mathematics congregate at Node 35, where 164 students in this group are observed, with 114 classified as successful and 50 as unsuccessful. The students within this group constitute 3.1% of the entire dataset, and it has been noted that the majority of these students (69.5%) have achieved success. Students allocating between 240 and 275 minutes per week for learning mathematics congregate at Node 36. In this group, 4 students are observed, all classified as unsuccessful. Students dedicating more than 275 minutes per week for learning mathematics congregate at Node 37, with 26 students in this group, 21 of whom are classified as successful and 5 as unsuccessful. The students within this group represent 0.5% of the entire dataset, and it has been identified that the vast majority of these students (80.8%) are successful.

It is indicated that students, whose parents' education level is high school, vocational high school or open education, gather in Node 12 and it is seen that among 96 participants in this group, 75 students are successful and 21 students are unsuccessful. The students within this group constitute 1.8% of the entire dataset, and it has been determined that the majority of these students (78.1%) are successful. The determinant variable for a sub-branching in this node was identified as the "Use of ICT in the Class for Subject-related Activities." This led to the creation of three distinct branching points: utilization equal to or less than -1.2, between -1.2 and 0.57 (inclusive of 0.57), and greater than 0.57 for concluding the respective paths in this branch. Students using Information Technologies related to the Subject during Class equal to or less than -1.2 congregate at Node 38, where 20 students in this group are observed, with 19 classified as successful and 1 as unsuccessful. he students within this group make up 0.4% of the entire dataset, and it has been ascertained that the vast majority of these students (95%) are successful. Students using ICT in the class for subject-related activities at a rate between -1.2 and 0.57 gather at Node 39. In this group, 32 students are noted, with 18 classified as successful and 14 as unsuccessful. The students within this group represent 0.6% of the entire dataset, and it has been determined that the majority of these students (56.2%) are successful. Students utilizing Information Technologies related to the Subject during Class more than 0.57 gather at Node 40, with 44 students in this group observed, comprising 38 classified as successful and 6 as unsuccessful. The students within this group represent 0.8% of the entire dataset, and it is seen determined that the vast majority of these students (86.4%) are successful.

It is pointed out that students, whose parents' education level is open high school and open education, accumulate in Node 13 and it is seen that among the 128 participants in this group, 66 of them are successful while 62 of them are unsuccessful. The students within this group constitute 2.4% of the entire dataset, and it has been determined that the majority of these students (51.6%) are successful. The determinant variable for a sub-branching in this node was identified as the "Use of ICT in Class for Subject-related Activities". This led to the establishment of two different branching points: utilization equal to or less than 0.57, and greater than 0.57, for concluding the respective paths in this branch. Students using Information Technologies related to the Subject during Class equal to or less than 0.57 gather at Node 41, where 72 students in this group are observed, with 29 classified as successful and 43 as unsuccessful. The students within this group make up 1.4% of the entire dataset, and it is seen that the majority of these students (59.7%) are unsuccessful. Students using ICT related to the Subject during Class more than 0.57 gather at Node 42. Within this group, 56 students are observed, with 37 classified as successful and 19 as unsuccessful. The students within this group represent 1.1% of the entire dataset, and it has been determined that the majority of these students (66.1%) are successful. It is notable that as the utilization of ICT in class for subject-related activities exceeds 0.57, students significantly improve in their performance.

It is illustrated that 282 students, whose parents' education level is open education and open university, gather in Node 14. 232 of these students in this group have been identified successful while 50 of these students have been found unsuccessful. The students within this group account for 5.3% of the dataset, and it has been established that the vast majority of these students (82.3%) are successful. In this node, the determinative variable for a sub-branching has been the "Overall Use of ICT in School." The establishment of two distinct branching points was made, with technology use equal to or less than 0.84 and greater than 0.57, leading to the conclusion of the respective pathways within this branch. Within Node 43, students whose 'Overall Use of ICT in School' equals or is less than 0.84 are observed, making up a group of 252 students. In this group, 217 students are classified as successful, while 35 are deemed unsuccessful. These students represent 4.8% of the entire dataset, with the significant majority (86.1%) demonstrating successful outcomes. Conversely, Node 44 encapsulates students whose 'Overall Use of ICT in School' surpasses 0.84, totalling 30 students. Among this smaller group, half of the students (50%) are classified as successful. They account for 0.6% of the entire dataset. The trend observed indicates a significant increase in academic success as 'Overall Use of ICT in School' diminishes below the 0.84 threshold.

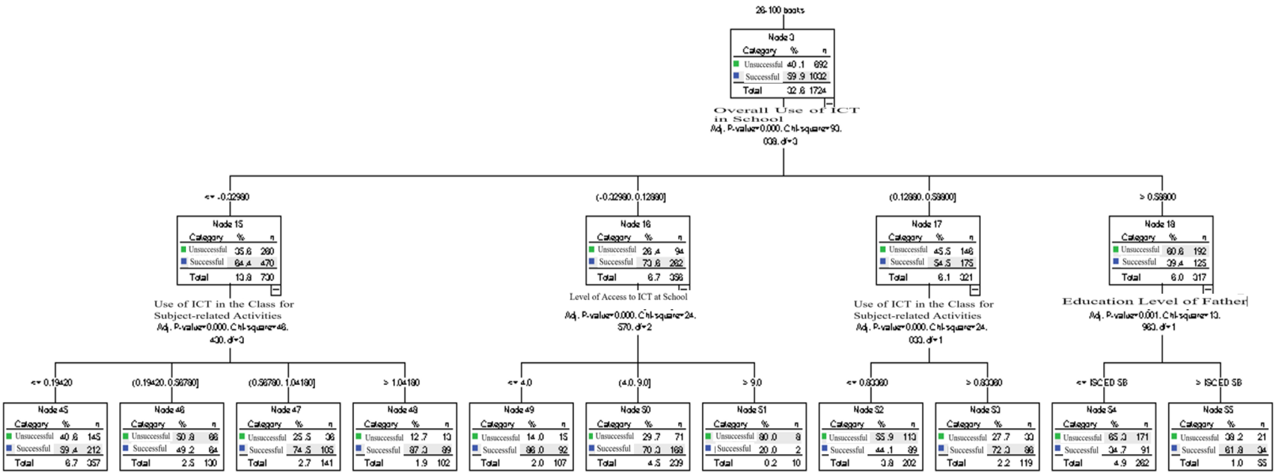

Figure 4. The Third Node Formed as a Result of CHAID Analysis (Node 3)

The variable that best explains the mathematical literacy of students with a range of 26-100 books at home is determined to be the "Overall Use of Information Technologies in School" (χ^2=93.04, p=.000). According to this variable, a significant distinction in the success statuses of the students has been observed, and four branching points have been identified at the third node. The scores for the "Overall Use of ICT at School" variable among students have ranged from -1.72 to 3.3.

Students with "Overall Use of ICT at School" scores less than or equal to -0.32 gather at Node 15, where 730 students are classified, with 470 being successful and 260 unsuccessful. The students in this group make up 13.8% of the dataset, and a majority of them (64.4%) have been identified as successful. The variable that determined a lower-level branching at this node is "Use of ICT in the Class for Subject-related Activities", showing scores ranging from -1.22 to 2.44. Use of ICT in the Class for Subject-related Activities defines four different node points based on time frames: less than or equal to 0.19 minutes, between 0.19 and 0.57 minutes (inclusive), between 0.57 and 1.04 minutes (inclusive), and greater than 1.04 minutes, marking the conclusion for the relevant branch. During class, students who use Information Technologies related to the Subject for 0.19 minutes or less are gathered at Node 45, where a group of 357 students is classified, consisting of 212 successful and 145 unsuccessful students. The students within this cluster constitute 6.7% of the dataset, with the majority (59.4%) demonstrating a successful academic performance. The students with the "Use of ICT in

Class for Subject-related Activities" scores falling between 0.19 and 0.57 are clustered at Node 46, where 130 students are observed, with 64 classified as successful and 66 as unsuccessful. The students in this group comprise 2.5% of the dataset, with the majority (50.8%) identified as unsuccessful. Students whose "Use of ICT in Class for Subject-related Activities" ranges between 0.57 to 1.04 are gathered at Node 47, with 141 students observed: 105 of them classified as successful and 36 as unsuccessful. The students in this group constitute 2.7% of the dataset, with the majority (74.5%) identified as successful. The students gathered at Node 48, who exceed 1.04 in their use of IT related to the subject during class, consist of 102 individuals. In this group, 89 were classified as successful, and 13 as unsuccessful. These students represent 1.9% of the dataset, with the vast majority (87.3%) identified as successful.

"General Use of ICT in School" shows that students from -0.32-0.12 are gathered in Node 16. 356 students in this group, 262 are identified as successful and 94 are identified as unsuccessful. Students in this group make up 6.7% of the data set, and the majority of these students (73.6%) were found to be successful. The defining variable for the subdivision in this node is "Level of Access to ICT at School" and the variable scores range from 0 to 10. Three different nodes are determined in terms of ICT accessibility at school. These are ICT accessibility less than and equal to 4, between 4-9 (including 9) and greater than 9. Students with a score of less than 4 and equal to "Level of Access to ICT in School" are clustered in node 49. 92 of the 107 pupils in this group are classified as successful and 15 of them are identified as unsuccessful. Students in this group represent 2% of the dataset and the vast majority of these students (86) are classified as successful. Students who score between 4-9 in terms of "Level of Access to ICT in School" are grouped in node 50. Among 239 students in this group, 168 are successful and 71 are unsuccessful. Students in this group represent 4.5% of the dataset, and the majority of these students (70%) are determined as successful. Students scoring above 9 regarding the "Level of Access to ICT in School" are clustered in node 51, and that 2 of the 10 students in this group are successful while the rest 8 are unsuccessful. Students in this group represent 0.2% of the dataset and the majority of these students (80%) failed. It has been observed that the less ICT is available in schools, the more students succeed.

It is seen that students who score between 0.12-0.59 in terms of their "General Use of ICT in School" cluster in Node 17. Among 321 students in this group, 175 of them are defined as successful while 146 of them are identified as unsuccessful. The students in this group make up 6.1% for the whole data set and it is observed that majority of the students (54.5%) are successful. In this Node, the variable responsible for the subdivision is "Use of ICT in the Class for Subject-related Activities". Two different nodes are created regarding the use of ICT for subject-related activities in the class. These are level of using ICT during class for subject-related activities lower than or equal to 0.83 and higher than .83. It can be understood that students who score equal to or lower than .83 cluster in Node 52. Among 202 students in this group, 89 of them are classified as successful while 113 of them are named as unsuccessful. Students in this group composes 3.8% of the whole data set and majority of these students (55.9%) are unsuccessful. It can be seen that students who score higher that .83 cluster in Node 53. Of the 119 students in this group, 86 are successful and 33 are unsuccessful. Students in this group compose 2.2% of the dataset and most of these students (72.3%) are successful. It was found that the higher the scores for the use of ICT during the course, the more significantly successful the students were.

Students who score higher than 0.59 in General Use of ICT in School" gather in Node 18. Of the 317 students in this group, 125 are regarded as successful and 192 are regarded as unsuccessful. Students in this group constitute 6% of the dataset, and the majority of these students (60.6) were classified as successful. A subdivision in this node is defined by the variable "Education Level of Father" and completion was made for the relevant branch by defining two node ends. These are the education level of father at open education or below and university and above. Students, whose fathers' level of education is open education or lower are grouped together in node 54 and that of the 162 students in this group, 91 are successful and 171 are unsuccessful. Students in this group make up 4.9% of the dataset and the majority of these students (65.3%) are found to be unsuccessful. The students with fathers whose level of education is university and above are collected at node 55, and 34 of the 55 students in this group are classified as successful and 21 as unsuccessful. Students in this group make up 1% of the dataset and the majority of these students (61.8%) are found to be successful. It is found that the higher the educational level of the father, the more successful the student.

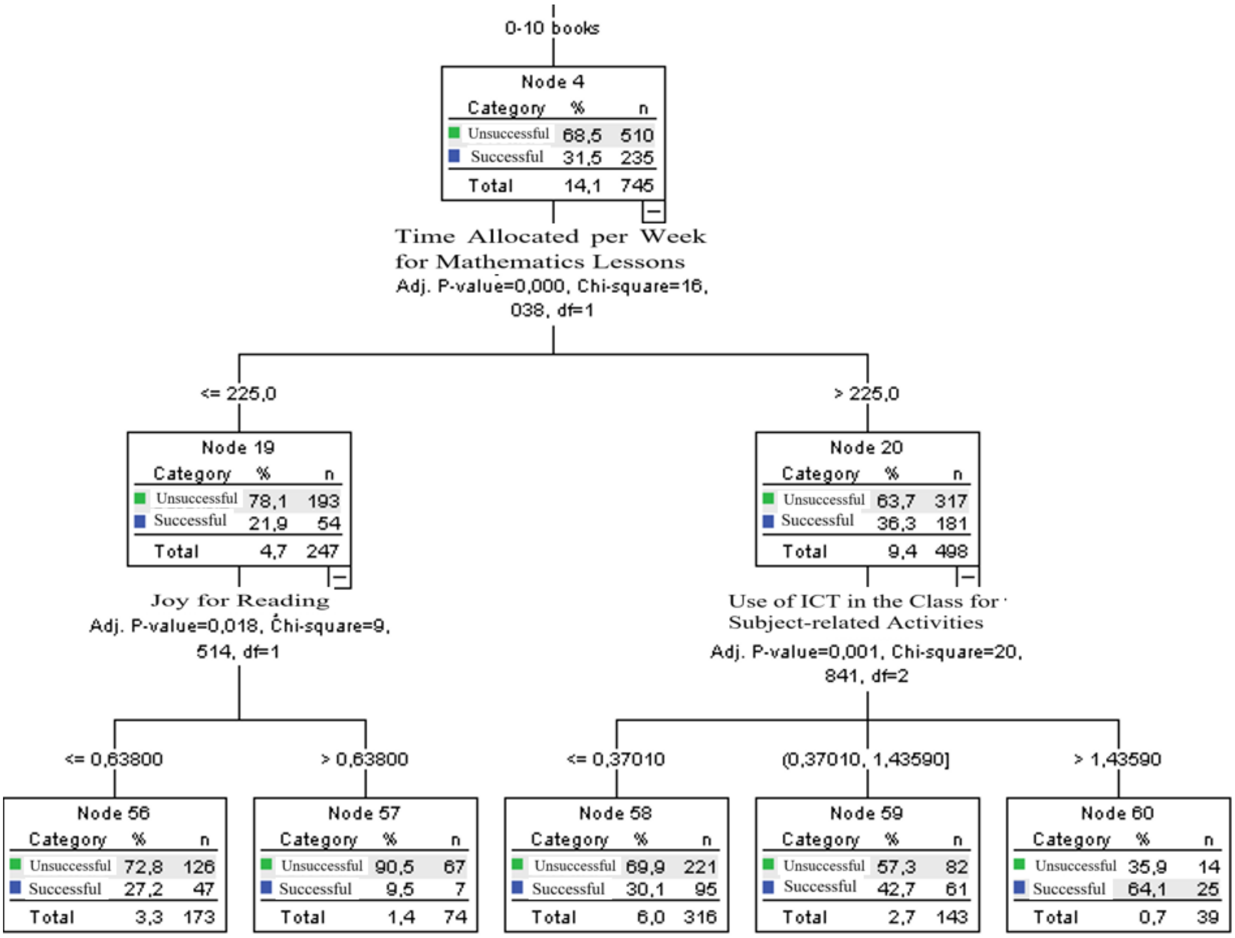

Figure 5. The Fourth Node Formed as a Result of CHAID Analysis (Node 4)

The variable that best describes the mathematical literacy of students who have books at home between "0-10" is found to be "Time Allocated per week for Mathematics Lessons" (χ^2=16.04, p=.000). According to this variable, there is a significant difference between the students' success status and the occurrence of two branches in the fourth node.

Students who allocate 225 minutes or less to study mathematics per week are grouped in Node 19. Of the 247 students in this group, 54 of them are identified as successful while 193 of them are identified as unsuccessful. Students in this group compose 4.7% percent of the whole data set and majority of them (78.1%) are found to be unsuccessful. The variable defining the sub-branches in this node is determined as "Joy for Reading". These sub-branches are students who scored equal to or lower than 0.64 and students who scored above 0.64 in terms of the joy for reading. Students scoring equal to or lower than 0.64 in "Joy for Reading" cluster in Node 56. Of the 173 students in this group, 47 of them are found to be successful and 126 of them are found to be unsuccessful. Students in this group make up 3.3% of the whole data set and majority of these students (72.8%) are determined as unsuccessful. Students with a "Joy for Reading" score greater than 0.64 are collected in Node 57. 74 students in this group, 7 are classified as successful and 67 are classified as unsuccessful. Students in this group compose 1.4% of the dataset, and the vast majority of these students (90.5) are deemed unsuccessful.

Students allocating more than 225 minutes to study Mathematics are grouped together in Node 20. Of the 498 students in this group, 181 are classified as successful and 317 as unsuccessful. Students in this group make up 9.4% of the dataset, and the majority of these students (63.7%) are named as unsuccessful. The determining variable for a subdivision in this node is “Use of ICT in the Class for Subject-related Activities”. These subdivisions are students with “Use of ICT in the Class for Subject-related Activities” less than and equal to 0.37 and between 0.37-1.44 (including 1.44) and greater than 1.44. Students with a score of less than 0.37 and equal to "“Use of ICT in the Class for Subject-related Activities”" are found at Node 58, with 95 of the 316 students in this group classified as successful and 221 as unsuccessful. Students in this group make up 6% of the dataset, and the majority of these students (69.9%) are found to be unsuccessful. Students with a score between 0.37 and 1.44 on "“Use of ICT in the Class for Subject-related Activities”" are collected in Node 59. 61 of the 143 students in this group are identified as successful and 82 of them are as unsuccessful. Students in this group compose 2.7% of the dataset and the majority of these students (57.3%) are unsuccessful. Students with a score of more than 1.44 on “Use of ICT in the Class for Subject-related Activities are placed in Node 60. Of the 39 students in this group, 25 are successful and 14 are unsuccessful. Students in this group represent 0.7% of the dataset and the majority of these students (64.1%) are successful. It can be understood that the greater the use of ICT on the subject during the course, the more significant the success of the students.

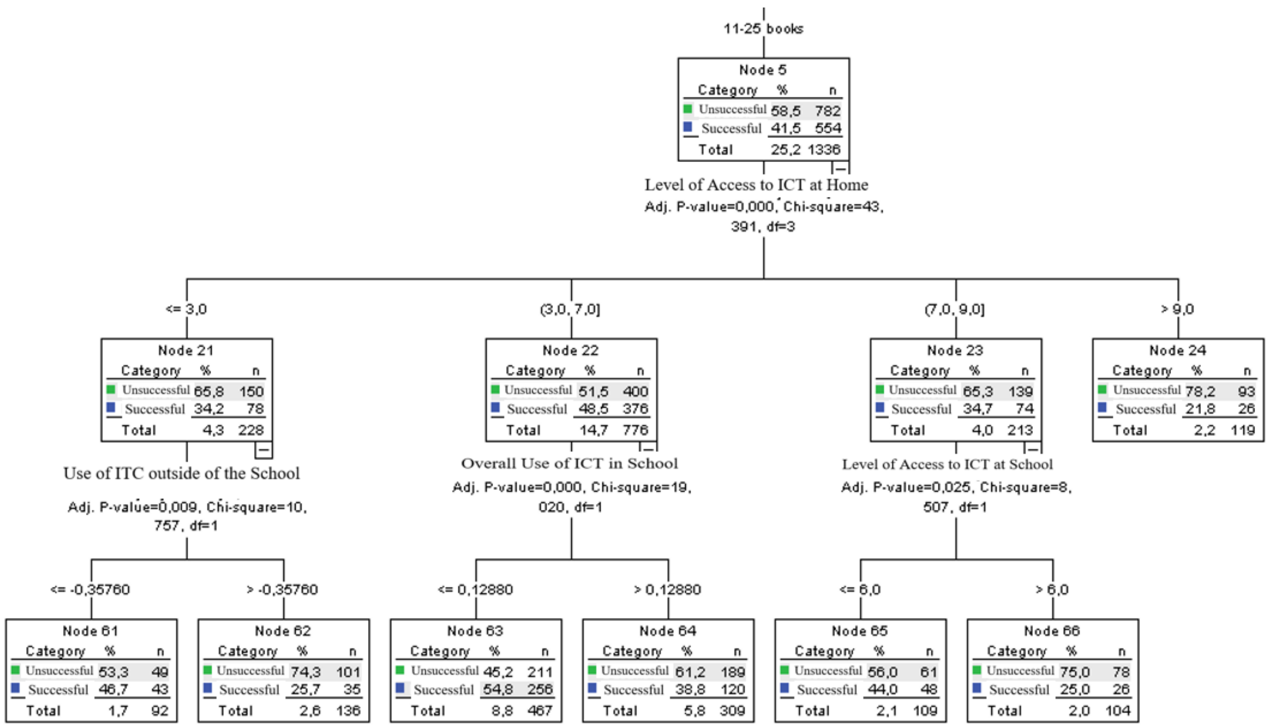

Figure 6. The Fifth Node Formed as a Result of CHAID Analysis (Node 5)

“Level of Access to ICT at Home” is found as the variable best explaining the mathematical literacy of the students who has books with a range of “11-25” at home (χ^2=43.39, p=.000). According to the variable, there is a significant difference between the students' success status and four sub-branches are determined in the fifth node. “Level of Access to ICT at Home” point ranges from 0 to 11.

Students, whose level of access ICT at home is lower than or equal to 3 are gathered in Node 21. Of the 228 students in this group, 78 of them are found to be successful while 150 of them are unsuccessful. Students in this group make up 4.3% of the dataset, and the majority of these students (65.8%) are identified unsuccessful. The defining variable for the sub-branching in this node is “Use of ICT outside of the School”, and this variable ranges from -2.3 to 3.31. In this line, two distinctive nodes are identified. These are the score for out-of-school use of ICT is less than and equal to -0.37 and higher than -0.37. Students with a score of less than and equal to -0.37 “Use of ICT outside of the School” are found in Node 61, where 43 of the 92 students in this group are successful and 49 are unsuccessful. Students in this group represent 1.7% of the dataset, and the majority of these students (53.3%) are unsuccessful. Students with a “Use of ICT outside of the School” score greater than -0.37 are gathered in Node 62, and 35 of the 136 students in this group are classified as successful and 101 are identified as unsuccessful. Students in this group represent 2.6% of the dataset, and the majority of these students (74.3%) are named as unsuccessful. Therefore, it can be deduced that the lower the BIT out-of-school use score, the more significantly successful the student.

Students, whose level of access ICT at home is between 3-7 are grouped together in Node 22. 376 of the 776 students in this group are classified as successful and 400 as unsuccessful. Students in this group represent 14.7% of the dataset, and the majority of these students (51.5%) are classified as unsuccessful. The variable “Overall Use of ICT in School” is found to be the determinant for the sub-branching in this node, and the closure for the respective branch is made by defining two different nodes. These are scores less than and equal to 0.13 and greater than 0.13 in terms of overall ICT Use in School. Students with a score of less than equal to 0.13 are found in Node 63. 256 of the 467 students in this group are classified as successful and 211 as unsuccessful. Students in this group represent 8.8% of the dataset, and the majority of these students (54.8%) were found to be unsuccessful. Students with an “Overall Use of ICT in School” score greater than 0.13 are collected in Node 64. Among 309 students in this group, 120 are successful and 189 are unsuccessful. Students in this group represent 5.8% of the dataset, and the majority of these students (61.2%) are unsuccessful. In general, the lower the level of ICT use in the school, the higher the level of student success.

Students, whose level of access ICT at home is between 7-9 (including 9) are grouped together in Node 23. That of the 213 students in this group, 74 are successful and 139 are unsuccessful. Students in this group represent 4% of the dataset and the majority of these students (65.3%) are unsuccessful. The defining factor for the sub-branching in this node was the variable "Level of Access to ICT at School" and the closure for the respective branch is achieved by defining two different node points. These node points are the level of ICT access at school lower than and equal to 0.6 and greater than 0.6. Students with a score of less than and equal to 0.6 are found at Node 65, with 48 of the 109 students in this group classified as successful and 61 as unsuccessful. Students in this group represent 2.1% of the dataset, and the majority of these students (56%) are found to be unsuccessful. Students with a "Level of Access to ICT at School" score greater than 6 are allocated in Node 66, where 26 of the 104 students in this group are successful and 78 are unsuccessful. Students in this group represent 2% of the dataset and the majority of these students (75%) are unsuccessful. In general, the lower the ICT use score in the school, the more successful the students.

Students, whose level of access ICT at home is greater than 9 are gathered in Node 24 and among 119 students in this group, 26 of them are identified as successful and 93 of them are identified as unsuccessful.

Students in this group make up 2.2% of the dataset and the majority of these students (78.2%) are found to be unsuccessful. This knot is terminated without forming any further sub-branching.

Moreover, in order to determine the best nodes (roots) to classify the students and reveal which of these nodes provide more information, gain values of the nodes are given in Table 3.

Table 3. Gain Values Concerning Success Status

Node	Node		Gain		Correct Answer Ratio	Index
	n	%	n	%		
10.Node	374	7,1%	340	11,6%	90,9%	163,6%
8. Node	73	1,4%	64	2,2%	87,7%	157,7%
14. Node	282	5,3%	232	7,9%	82,3%	148,0%
12. Node	96	1,8%	75	2,5%	78,1%	140,6%
16. Node	356	6,7%	262	8,9%	73,6%	132,4%
7. Node	183	3,5%	130	4,4%	71,0%	127,8%
15. Node	730	13,8%	470	16,0%	64,4%	115,8%
11. Node	269	5,1%	169	5,7%	62,8%	113,0%
9. Node	76	1,4%	43	1,5%	56,6%	101,8%
17. Node	321	6,1%	175	5,9%	54,5%	98,1%
13. Node	128	2,4%	66	2,2%	51,6%	92,8%
22. Node	776	14,7%	376	12,8%	48,5%	87,2%
18. Node	317	6,0%	125	4,2%	39,4%	70,9%
20. Node	498	9,4%	181	6,2%	36,3%	65,4%
23. Node	213	4,0%	74	2,5%	34,7%	62,5%
21. Node	228	4,3%	78	2,7%	34,2%	61,5%
6. Node	7	0,1%	2	0,1%	28,6%	51,4%
19. Node	247	4,7%	54	1,8%	21,9%	39,3%
24. Node	119	2,2%	26	0,9%	21,8%	39,3%

When Table 3 is investigated, it can be seen that the most influential node affecting the division of unsuccessful students is 10. Node (n=340, %11.6). This node is composed of 374 students who have more than 200 books at their home, whose fathers' educational level is open education and university. These students are classified correctly with a rate of 90.9%. gain values are examined to determine the second most effective node and 8. Node is determined as the second most effective one (n=64, %2.2). This node includes 73 students who have than 200 books at their home, whose fathers' educational level is vocational high school, open high school, and open education. These students are classified correctly at 87.7% rate. 14. Node is determined as the third most effective node in explaining the successful and unsuccessful students (n=232, %7.9). This node has 282 students with 101-200 books in their home with parents who went to open education and university. These students are classified correctly with a rate of 82.3%. On the other hand, the node which provides the least information on the division of the students is determined as Node 24 (n=26, %0.9). 119 students with the level of access to ICT at home above 9 and 11-25 books in their homes. These students were classified correctly with 21.8% accuracy.

4. DISCUSSION, CONCLUSION AND IMPLICATIONS

The objective of this study is to investigate the variables that have a significant impact on the mathematical literacy of students. The findings indicate that the "Number of Books in the House" is the key variable explaining the mathematical literacy of 15-year-old students in Turkey. According to the findings of the study, as the number of the books at home increases, students become more successful. These results are consistent with the other studies in the literature. In their study examining the 2012 PISA Mathematics Test Scores show differences in terms of certain variables. Turkan, Üner and Alcı (2015) found that the number of books in the home has increased the success of mathematics. In Gürsakal's (2012) study, which assessed the factors affecting PISA 2009 student success rate, found that an increase in the average number of books at home increased math achievement. In another study by Kahraman and Çelik (2017) determining personal and environmental factors that influence PISA 2012 scores of the students, it was concluded that the number of books variable has an impact on the success of mathematics lessons. Karabay (2013) explored the family and school characteristics that impact the students' success in PISA examinations. It was concluded that the quantity of the books at home was a statistically significant variable affecting both PISA examinations (2003, 2006, 2009) and fields of expertise that included literacy, maths and science literacy. Gilleece, Cosgrove, and Sofronionu (2010) researched the variables of pupils and the educational background in relation to poor or outstanding performance in mathematics and science as per the PISA 2006 outcomes. They discovered that the number of books at home was considerably linked to accomplishments in mathematics and science at the student level. In another study, Aslanoğlu (2007) delved into the factors that affect the reading comprehension ability of 4th-grade students in Turkey by utilizing the 2001 PIRLS survey of students, teachers, and schools. When examining the family characteristics of students, it was concluded that the most influential family characteristic variable was found to be the quantity of books in the household. In a study by Zeybekoğlu and Koğar (2022) scrutinizing the factors that explain scientific literacy in regards to PISA 2015 data, it was found that the primary influential aspect on scientific achievement was the number of books at home. The research findings suggest that possessing a greater number of books in one's home significantly affects various aspects of not only mathematical literacy but also many other areas. The comprehension skills of students are vital to their achievement in both domestic and global exams. Consequently, it is at utmost importance that students are provided with opportunities to reach to a range of materials in their homes, and parents' level of awareness should be increased on this matter.

Education level of the father, highest education level of the parents, the level of access to ICT both at home and at school, and time allocated per week to study mathematics are also among the variables that explains mathematics literacy. This finding is supported by previous studies in the literature.

Aydın, Sarıer, and Uysal (2012) conducted a study comparing PISA math results on socio-economic and socio-cultural factors. The study found that student success is greater when parents have a higher educational level. Mutluer and Büyükkıdık (2017) found that a student's success can be affected by the educational level of the student's parents. Çanakçı and Özdemir's (2015) study examined the correlation between students' maths performance, their attitudes towards maths problem-solving, and their parents' level of education. The results indicated that higher educational levels of both the father and mother correlated with greater achievement in maths for the students. In Gürsakal' (2012) study evaluating the factors affecting 2009 PISA student success, it was discovered that parental education levels impact the success of mathematics lessons. The higher the educational attainment of the parents, the greater the resulting student achievement. Karabay, Yildirim and Güler (2015), in their study aiming at determining the factors related to students' mathematical literacy success who attended 2003, 2006, and 2009 PISA, revealed that students' families' educational level play a crucial role in determining students' success. They specified that it is worth considering that the self-improvement of the students' families has an impact on their success. In addition to research indicating that a mother's educational level has a greater impact on a student's maths performance than that of the father (Keskin and Sezgin, 2009), research has also discovered that the father's degree of education has a more significant effect than the mother's (Özer and Anıl, 2011). The research, which investigated the correlation between academic achievement in maths and parental education, revealed that the number of eighth-grade pupils excelling in mathematics corresponded to the level of educational attainment of their parents (Uysal and Yenilmez, 2011). Usta (2014) analysed the variables linked to the mathematical literacy competence of Finnish and Turkish pupils who took part in PISA 2003 and 2012 at both the student and school level. In this study, only in PISA 2012, it was uncovered that among the variables related to parental education levels, mothers' level of education had a positive association with mathematical literacy for Finland. Likewise, the variables related to parents' occupation exhibited a significant positive correlation with mathematical literacy. An investigation of PISA 2003 data by Martins and Veiga (2010) established that inequalities in parental education considerably influence students' accomplishments in mathematics. Moreover, numerous studies (Cameron and Heckman, 2001; Chevalier and Lanot, 2002; Haveman and Wolfe, 1995) stress that children's success is not affected by income alone, but rather, the educational level of their parents. Although family income has an independent and positive effect on educational outcomes (Teachman, 1987), it seems to be weaker compared to the impact of parental education (Blau, 1999; Ganzach, 2000). Shea's (2000) study revealed that parental income had a positive impact only on children whose parents had less than 12 years of education. Furthermore, the effects parental education was found to be more significant than social class (Erikson and Jonsson, 1996).

Çelen, Çelik, and Seferoğlu (2011) discovered that students who had access to computers at school achieved higher scores in mathematics and problem-solving in comparison to those who did not. Similarly, students who had computers at home achieved higher scores compared to those without such access. Similarly, Dibek, Yalçın, and Yavuz (2016) found out in their research that students who had ICT at home demonstrated higher levels of mathematical literacy than those who did not have such access. The study revealed that students who had access to technology at school scored higher in mathematical literacy than those who did not. Another study conducted by Hu, Gong, Lai, and Leung (2018) conceptualised ICT as multilevel constructs (at nation, school, and student levels) and investigated their relationship with student competence in mathematics, reading skill, and scientific literacy. The researchers found that national ICT skills had a more beneficial impact on students' academic performance than national ICT access and usage; (ii) ICT presence in schools had a positive correlation with academic performance, while home ICT availability had a negative association, (iii) The academic use of ICT demonstrated a negative correlation with student performance, whereas entertainment-oriented ICT use had a positive correlation, (v) Student attitudes towards ICT demonstrated mixed effects on academic achievement - specifically, student interest, competence and autonomy in ICT use showed positive correlations, while enjoyment derived from social interaction gained through CT had a negative correlation with academic performance. The findings suggest that the appropriate and timely utilization of ICT, both at home and at school, can contribute to academic success. While providing access to ICT at home offers numerous educational opportunities, misusing it for educational purposes can hinder a student's learning. Koğar (2015), in his study which aimed to reveal the direct and indirect factors that affect mathematical literacy in the PISA 2012, uncovered that independent variables, including gender, financial status, time dedicated to learning mathematics, and socio-cultural status index, had a notable impact on mathematical literacy. In another study conducted by Özer and Anıl (2011) using PISA 2006 data analysed by structural equation modelling both on student and school level, it was found that although time allocated to studying was revealed as the primary predictor of student achievement, investing more time in mathematics by participating in activities such as attending classes and courses did not have a significant effect on mathematical literacy. Usta (2014) identified a significant positive correlation between time spent on out-of-school education and mathematical literacy, based on PISA 2003 and PISA 2012 data from Turkey. However, while Finland PISA 2003 data displayed a significant negative relationship, no significant relationship was observed in the PISA 2012 data. Liu, Wei, Xiu, Yao, H., and Liu (2023) conducted a study using PISA 2018 data to explore the ideal duration for improving academic performance among students. The study reached to the conclusion that study time and academic achievement had a relationship that resembled an inverted U-shape. Regarding the influence of study time, the outcomes suggested being committed to the study times was more effective for students who were academically disadvantaged. Moreover, this study identified a correlation between excessive study time and students' subjective well-being and attitudes towards learning activities. That is, non-cognitive factors were found to affect students' academic performance gradually. The researchers proposed that students should establish a balance between their study time and appropriate learning time standards. Furthermore, schools should implement varying study schedules for students across different academic performance levels. Teachers should adopt a more objective approach to students' post-school tasks, while simultaneously prioritising the improvement of students' academic performance.

According to these findings, for Turkey to be placed in higher rankings in exams with broad participation like PISA, the number of the books in the houses can be increased, both the students' and the parents' awareness on developing reading habits can be raised, the education level of the families can be increased, courses on how to use ICT efficiently can be designed, and research on rescheduling the course hours can be done. It can be seen that education is a holistic concept and success cannot be reached without the participation of the all stakeholders. In this line, the parents should be informed that they need to exhibit exemplary behaviour, and family education should be a part of adult education. It is clear that reading habit is the most important factor affecting not only the success in many courses but also mathematics literacy. In this context, families can be encouraged to increase the number of the books in their homes, parents can be informed about forming libraries in the houses, and family reading hours can be scheduled. Although having access to ICT is advantageous, misusage of ICT tools can also be disadvantageous, too. Teachers can provide proper guidance on how to use ICT when doing homework and they can give homework which will help students realize the rich educational ICT resources. Moreover, time allocated for mathematics teaching at schools can be rescheduled. The quality of the hours allocated for mathematics teaching should be as important as the quantity of it.

This study has some limitations as it included only Turkish sample. Thus, more studies should be carried out with data gathered from different nations. Factors affecting mathematics literacy can be examined by other analysis methods and finding can be compared with the results gained through CHAID analysis. In this study, variables affecting mathematics literacy were investigated. Variables affecting 2018 PISA science literacy and reading skills can be examined and common variables can be detected.

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