

Determining Students' Cognitive Profiles and Deficiencies In Foreign Language Education through Cognitive Diagnosis Models

Bilişsel Tanı Modelleriyle Yabancı Dil Öğretiminde Öğrencilerin Eksiklerinin ve Bilişsel Profiline Belirlenmesi

Tahsin Oğuz BAŞOKÇU

Ege Üniversitesi, Eğitim Fakültesi, Eğitim Bilimleri Bölümü, Eğitimde Ölçme ve Değerlendirme Anabilim Dalı, İzmir, Türkiye

Didem KOŞAR

Hacettepe Üniversitesi, Eğitim Fakültesi, Eğitim Bilimleri Bölümü, Eğitim Yönetimi Anabilim Dalı, Ankara, Türkiye

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Abstract

This study aims at observing the development in students' cognitive profiles in relation to English education. In this sense, the present study employs cognitive diagnosis models to determine student lacks and profiles in foreign language education. The sample of the study includes prep class students studying at Ege University, School of Foreign Languages in the 2012-2013 academic years. The students taking the proficiency exam held at the beginning of the year and the final exam held at the end of the year were included in the sample. Data regarding both exams indicated that 564 students took both final and proficiency exams. Therefore, this group was selected as sample. Descriptive statistics show that both tests have high levels of reliability. In addition, skewness and kurtosis coefficients indicate that neither of the tests has extreme deviation from the normal distribution. According to the analysis results, the students had few characteristics in the proficiency test, but they increased in the final test.

Keywords: Foreign language, English, proficiency test, final test

Özet

Bu çalışmanın amacı yabancı dil olarak İngilizce öğretiminde öğrencilerin bilişsel profil gelişimlerini ortaya koymaktır. Bu bağlamda araştırma, yabancı dil öğretiminde öğrencilerin eksiklerinin neler olduğunu ve öğrenci profillerini belirlemektedir. Araştırmanın örneklemi 2012-2013 akademik dönemde Ege Üniversitesinde okumakta olan Hazırlık sınıfı öğrencilerinden oluşmaktadır. Hazırlık sınıfı öğrencilerinin dönem başında aldıkları muafiyet sınavı ile yılsonunda yapılan final sınavı örnekleme dâhil edilmiştir. Veriler, 564 öğrencinin hem final hem de muafiyet sınavını aldıklarını gösterdiği için bu grup örneklem olarak araştırmaya dâhil edilmiştir. Betimsel analizler, her iki sınavın yüksek güvenilirliğe sahip olduğuna işaret etmektedir. Buna ilaveten, eğrilik ve çarpıklık katsayısı testlerin normal dağılımdan aşırı sapma göstermediğini ortaya koymuştur. Analiz sonuçlarına göre öğrenciler muafiyet sınavında düşük

beceriler gösterirken final sınavında bu becerilerin yükseldiği saptanmıştır.

Anahtar Kelimeler: Yabancı dil, İngilizce, muafiyet sınavı, final sınavı

1. Introduction

International relations increase as a result of scientific, technological, and commercial developments, which lead societies to be closer to each other. Hence, interactions between different cultures rise. Foreign language is considered the main mediator to keep up with the changing technology, access the needed information, learn various cultures, and communicate with people from these cultures. In this sense, foreign language education has become important for people of global economy and for people who live in societies in which a couple of languages are used together (Agresto, 1985, as cited in Ganschow, Sparks & Javorsky, 1998). The individuals of today's world are expected to both use their native languages efficiently through effective interaction skills and to learn another foreign language and use it competently as well (Ertürk & Üstündağ, 2007). Foreign language education is a part of education policies in many countries, and various languages are taught as foreign languages. The main function of foreign languages is to ensure certain relations and sharing beyond communication. The common language in this global communication is English (Alptekin, 2005). Since it is the most common language used in Turkey and around the world, English is the prominent foreign language (Çiğerci, 2009).

Foreign language education is a process involving cognitive behaviors and psychomotor skills and developing through accumulation (Demirel, 2007). Four main skills that need to be acquired to learn a language are listening, reading, writing, and speaking. It is believed that writing skill helps students to reinforce the structures or the vocabulary they have learnt, to notice the incorrect use of language, to learn punctuation, to think creatively, and to transform their skills into performance (Çakır, 2010). Reading skill is an active and creative process where one derives information from the reading text and integrates it with his/her own knowledge, ideas, and purposes (Er, 2005). Speaking skill involves mutual conversation and constant thinking in the sub-dimensions of understandability, grammar, vocabulary, and fluency (Byrne, 1986; Ertürk & Üstündağ, 2007; McDonough, J., Shaw & Masuhara, 2013). It is stated that the important components of speaking skill are sounds, emphasis, and intonation as well as understanding various accents and the words pertaining to spoken language while using visual and environmental clues all the time (Sarçoban, 1999). Learning environments should be equipped with the most effective teaching materials in order to equip individuals with these four skills effectively (Ertürk & Üstündağ, 2007). Grammar is also important in addition to these four skills. Lack of grammar is an important problem in English education.

Just like the rest of the world, Turkey has spent serious amount of time and money for foreign language education. However, achievement in foreign language education is generally not at the desired level (Demirel, 2000). Previous studies report that many people succeeding in mathematics, social sciences, and physical sciences cannot achieve the desired success in foreign language. One of the reasons is the phonological or

punctuation principles of the foreign language for learners (Ganschow, et all, 1998). Another problem is young learners' forgetfulness and problems experienced in their native language: the problem of being able to be bilingual or not (Fillmore, 1991). Among other problems are traditional language teaching habits that have dominated a long period of time, the lacks in the planning of foreign language teaching, and the lacks or wrongs related to methods, activities, materials, and assessment-evaluation stemming from the lacks in teaching plans (Paker, 2006). In this sense, Demirel (2000) listed the main principles of foreign language education as follows: improving four skills, planning the education activities beforehand, instruction from simple to complicated and concrete to abstract, using native language only when necessary, transferring the knowledge to daily life, allowing active participation of students, motivating and encouraging students, and taking into account individual differences.

Reading and grammar sub-skills which are used to determine learner profiles in English teaching (Alderson 2005; Jang, 2009) are displayed in the table below in 15 items.

Table 1. Reading and Grammar Sub-Skills

Skills	Definition
CDV	1-Finding out the meaning of the word or phrases by studying and analyzing the text or using the contextual clues within the text
CIV	2-Revealing the meaning of the word through context by consulting the previous knowledge
SSL	3-Comprehending the connection between the parts of successive sentences without logical errors through instruments that comply with semantic and grammatical principles
TEI	4-Reading the paragraphs of a text fast in order to have the meaning of text pieces
TIM	5-Selective reading of the paragraphs in order to identify and distinguish the explicit expressions that depend on implicit ones within the text
INF	6-Making deductions from the discussions within the text or understanding the purpose of the writer from implicit meanings or previous knowledge
NEG	7-Fast and attentive reading of the information within the text and deciding which information is correct or incorrect
SUM	8-Analyzing and evaluating the relative information within the text by distinguishing the main ideas from supportive details
MCF	9-Recognizing main discussions and comparisons whose verbal structure includes comparison, cause-and-effect, and alternative discussions and placing them within a mental frame
Structure Knowledge	10-Nouns -NON
	11-Adjectives -ADJ
	12-Pronouns-PRN
	13-Verbs-VRB
Sentence Knowledge	14- Conjunctions-CON
	15-Speaking parts-SPP

15 characteristics that are used to determine student profiles are Vocabulary Phrase Skills (CDV), Vocabulary Skills (CIV), The Skill of Association Between Parts (SSL), Fast Reading Skill (TEI), Selective Reading Skill (TIM), Deduction Skills (INF), Confirmation-Falsification Skill (NEG), Summarization Skill (SUM), Comparison Skill (MCF), Noun (ISM), Adjectives (SFT), Pronoun (ZMR), Verb (FIL), Conjunction (BGL), and Speaking (SPP). In this sense, revealing the meaning of the

word through clues within the text refers to Vocabulary Phrase Skills; determining the meaning of the word depending on previous knowledge refers to Vocabulary Skill; comprehending the connection between the parts of successive sentences through semantic and grammatical rules refers to The Skill of Association Between Parts; fast reading of the paragraphs in a text to understand its parts refers to Fast Reading Skill; selective reading to identify the explicit expressions that are based on implicit expressions within the text refers to Selective Reading Skill; deducing the purpose of the writer through implicit meanings or previous knowledge refers to Deduction Skills; deciding which information is correct and which is not within the text refers to Confirmation-Falsification Skill; distinguishing and analyzing the main ideas within the text refers to Summarization Skill; placing the main comparisons and discussions that involve cause-and-effect and comparison within a mental frame refers to Comparison Skill.

Whether students possess the above-summarized skills will be revealed through the Fusion Model, which is one of the Cognitive Diagnosis Models (CDMs), in the present study. CDMs turned out to be on the agenda in the 2000s again and became more common in the course of time. It has latent class analysis in its core. Latent class analysis is a statistical method using multivariate categorical data and benefiting from associated situations to determine sub-groups. It was developed to estimate the development of a knowledge structure or a skill in students taking into account the strengths and weaknesses in their cognitive levels (Leighton & Gierl, 2007). Main purpose of this approach is to provide cognitive feedback to students, teachers, and parents. There is feedback about the profile of each student, the characteristics s/he has, and the learning deficiencies s/he has (Cheng, 2010). In this sense, the present study employs cognitive diagnosis models to determine student lacks and profiles in foreign language education.

2. Method

This study aims at observing the development in students' cognitive profiles in relation to English education. In this sense, the sample of the study includes prep class students studying at Ege University School of Foreign Languages in the 2012-2013 academic years. The students taking the proficiency exam held at the beginning of the year and the final exam held at the end of the year were included in the sample. Data regarding both exams indicated that 564 students took both final and proficiency exams. Therefore, this group was selected as sample.

The proficiency and final tests used in English preparation education includes 70 items. 30 of the items in this test measure Structure and Use of English while 40 measure Reading Comprehension skills. Descriptive statistical data of these two tests employed in the study are given in the table below.

Table 2. The Descriptive Statistics of the Proficiency and Final Tests

	Proficiency Test	Final Test
Number of Items	70	70

	Proficiency Test	Final Test
N	960	2237
Mean	24.176	38.168
Variance	193.912	81.703
Standard Dev.	13.925	9.039
Skewness	0.909	-0.328
Kurtosis	0.791	0.037
Median	20.000	39.000
Reliability Alpha	0.936	0.838
SEM	3.517	3.639

Descriptive statistics show that both tests have high levels of reliability. In addition, skewness and kurtosis coefficients indicate that neither of the tests has extreme deviation from the normal distribution.

Item difficulty (P_j), item discrimination index (R_{jx}), and item double serial correlation coefficient (R_{nc}) averages of both tests are given in the table below.

Table 3. Item Analyses of the Proficiency and Final Tests

	Proficiency Test			Final Test		
	P_j	R_{jx}	R_{nc}	P_j	R_{jx}	R_{nc}
Mean	0.345	0.452	0.444	0.545	0.319	0.310
Min	0.14	0.13	0.18	0.13	0.15	0.25
Max	0.83	0.90	0.72	0.95	0.51	0.41

Values higher than .30 indicate high discrimination in item-test correlations (Hambleton & Zaal, 1991). The analysis tables of both tests show that both mean R_{nc} values and R_{nc} values of each item indicate adequate discrimination. Similarly, it is seen that that discrimination values of tests are at adequate level.

With the help of 3 experts, Q matrices were determined for both tests for the analyses concerning the Fusion Model. Q matrix is a matrix defining which characteristic of items is measured in the CDM. In this matrix, there are characteristics in the columns and items in the rows. An item in the CDM can be associated with more than one characteristic. The Q matrices used in the study are given in the Appendix 1. The experts matched 15 characteristics with the items, thereby preparing the Q matrices. Final Q matrices were obtained comparing the Q matrices obtained from each expert and taking into account the experts' agreements.

The Fusion Model takes the item parameters determined for the items associated with the measured characteristic as reference while estimating student skills. It makes a categorical decision as to whether the student has the measured characteristic or not. In this sense, model fitness is associated with the estimated item parameters. Similarly, model fitness determines to what extent student skill estimation is accurate.

The mean values of the π_i , τ_{ik} and c_i parameters belonging to the proficiency and final tests are given in the table below.

Table 4. π_i^* , r_{ik}^* , and c_i and c_i Parameter Values Belonging to the Proficiency and Final Tests

	π_1^*	r_{11}^*	r_{21}^*	r_{31}^*	r_{41}^*	r_{51}^*	r_{61}^*	r_{71}^*	r_{81}^*	r_{91}^*	r_{101}^*	r_{111}^*	r_{121}^*	r_{131}^*	r_{141}^*	r_{151}^*	c_i
Prof.		0.63	0.58	0.64	0.46	0.33	0.78	0.79	0.47	0.39	0.34	0.40	0.38	0.46	0.34	0.37	10
Final		0.63	0.58	0.64	0.46	0.77	0.77	0.73	0.73	0.79	0.75	0.69	0.76	0.74	0.71	0.74	10

π_i^* parameter in the model solves the item when the respondent has all the characteristics determined by the Q matrix for the item i . Thus, it gives the probability of using these characteristics accurately. This probability is closely associated with item difficulty for the Q matrix. It takes a value from 0 to 1. Considering π_i^* values of the items in the proficiency and final tests, it is seen that items fit the item difficulty indices. For both tests, Spearman-Brown correlation coefficients between item difficulties and π_i^* values are positive, high, and statistically significant (proficiency=0.74, $p=0.001$; final=0.96, $p=0.001$).

In the Fusion Model, r_{ik}^* is an indicator of diagnosis capacity of the item i for the characteristic k . Having a value lower than 0.75 indicates adequate fitness. As this value lowers, the item's capacity to define the characteristic raises. For both tests, r_{ik}^* values related to the characteristic with which the items are associated show that the items represent the characteristic at an adequate level. In general, item fitnesses for the characteristics are at good levels. In addition, the real indicator of the item-Q matrix fitness is considered to be c_i parameter (Louis & Sarah, 2007). c_i parameter in the model indicates the relationship of the item response function with the characteristics that are not determined by the Q matrix. In this sense, low c_i value means that the item is rather associated with θ_i . That is, there is a deficiency at definition level in the Q matrix. Maximum value of this parameter is 10. Analysis results indicate that the c_i parameter of all the items is "10". This means that the proficiency test items used in the study are represented by the Q matrix at high levels.

This result indicates that the items in the proficiency and final tests and the Q matrices determined according to these items can be used to determine the students' cognitive profiles.

3. Findings

This section includes the distribution of the characteristics obtained from the study as well as the students' cognitive profiles.

Findings Regarding the Distribution of the Characteristics

The students' cognitive profiles were aimed to be determined according to the characteristics selected in the study. In this sense, the Fusion Model was employed to reveal the characteristics which were held by the students. The table showing how many characteristics the students had according to the proficiency and final tests results is below.

Table 5. The Characteristics Possessed by the Students According to the Proficiency and Final Test Results

Proficiency				Final			
Total Cha.	f	%	T%	Total Cha.	f	%	T%
0	16	2.8	3	0	2	0.4	0
1	20	3.5	6	1	3	0.5	1
2	176	31.2	38	2	4	0.7	2
3	40	7.1	45	3	4	0.7	2
4	31	5.5	50	4	6	1.1	3
5	17	3	53	5	7	1.2	5
6	10	1.8	55	6	15	2.7	7
7	14	2.5	57	7	10	1.8	9
8	13	2.3	60	8	22	3.9	13
9	14	2.5	62	9	25	4.4	17
10	16	2.8	65	10	25	4.4	22
11	28	5	70	11	41	7.3	29
12	20	3.5	74	12	77	13.7	43
13	25	4.4	78	13	94	16.7	60
14	51	9	87	14	107	19	79
15	73	12.9	100	15	122	21.6	100
Total	564	100		Total	564	100	

Total percentage column in the table above indicates that 50% of the group had 4 or fewer characteristics in the proficiency test. It is seen that the students had few characteristics in the proficiency test. Final test analysis results indicate that the same students turned out to have a lot of characteristics. For instance, 3% of the group had 4 or fewer characteristics in the final test. In addition, the students with less than 10 characteristics make up 22% of the group. This indicates that 78% of the group had 11 or more characteristics. This rate is 30% in the proficiency exam. These results indicate that majority of the group acquired the characteristics during the period between the proficiency and final tests.

Comparison of the proficiency and final tests according to the classic measure of success determined based on students' total scores yields a similar result. The group in the proficiency exam concentrated in lower scores while concentration was in higher scores in the final exam. The relationship between the students' total scores and the characteristics they had was analyzed via Spearman-Brown rank order correlation coefficient. There is a high, positive, and statistically significant relationship between the proficiency test total scores and the total number of the characteristics the students had calculated through the Fusion Model analysis ($r = 0.893$, $p > 0.01$). Similarly, there is a high, positive, and statistically significant relationship between the final test total scores and the total number of the characteristics the students had ($r = 0.929$, $p > 0.01$). This indicates that the Fusion Model analyses and the students' total scores fit each other.

Findings Regarding the Development of the Characteristics

The students' levels of possessing the characteristics were analyzed according to the changes from the proficiency test to the final test. The table below shows whether the students possessed the characteristics or not. 0 refers to not possessing the characteristic while 1 refers to possessing the characteristic in the proficiency and final tests.

Table 6. The Development of the Characteristics from the Proficiency Test to the Final Test

	Profic. -Final 0-0		Profic. -Final 0-1		Profic. -Final 1-0		Profic. -Final 1-1	
	f	%	f	%	f	%	f	%
CDV	97	17.2	174	30.9	98	17.4	195	34.6
CIV	80	14.2	196	34.8	80	14.2	208	36.9
SSL	93	16.5	191	33.9	81	14.4	199	35.3
TEI	177	31.4	129	22.9	111	19.7	147	26.1
TIM	79	14.0	310	55.0	31	5.5	144	25.5
INF	11	2.0	74	13.1	63	11.2	416	73.8
NEG	10	1.8	74	13.1	62	11.0	418	74.1
SUM	48	8.5	289	51.2	20	3.5	207	36.7
MCF	60	10.6	295	52.3	22	3.9	187	33.2
NON	55	9.8	321	56.9	18	3.2	170	30.1
ADJ	49	8.7	306	54.3	22	3.9	187	33.2
PRN	50	8.9	321	56.9	17	3.0	176	31.2
VRB	47	8.3	267	47.3	38	6.7	212	37.6
CON	10	1.8	373	66.1	5	0.9	176	31.2
SPP	52	9.2	293	52.0	19	3.4	200	35.5
Total	918	10.9	3613	42.7	687	8.1	3242	38.3

The first column in the table above shows the characteristics. The following columns show whether the students possessed the characteristics for the proficiency and final tests. The column with 0-1 shows that the students gained the characteristics during the period between the proficiency and final tests. The next column shows the percentage of the students in that group. The students in the columns 0-0 and 1-1 did not experience any change in the period between the proficiency and final tests in terms of possessing the characteristics. The column 1-0 shows the students who had the characteristics in the proficiency test whereas they did not have them in the final test. For example, there are 97 students who did not have the CDV characteristic in the proficiency and final tests. These students make up 17% of the group. There are 174 students who did not have this characteristic in the proficiency test, but had it in the final exam. This number of students corresponds to 30% of the group. The column 0-1 is particularly important in the table with the results it indicates. 50% of the group did not possess CON, NON, PRN, VRB, SPP, SIF, SUM, and TIM characteristics in the proficiency test, but they acquired them until the final test.

In general, the rate of the students possessing the characteristics in the final test is

81%. The rate of the students who acquired the characteristics in the period between the proficiency and final tests is 42.7%. 53.6% of the group did not possess the characteristics in the proficiency test while 42.7% of the group acquired these characteristics through the education they received. This rate is nearly 80%. In this sense, it is possible to say the education provided every 4 out of 5 students who did not have the characteristics before the education with the characteristics.

Findings Regarding the Individuals' Cognitive Profiles

564 students' cognitive profiles were revealed within the scope of the study. The Fusion Model shows whether the students possess a characteristic categorically via a statistical model. It shows the students' probability of possessing the characteristic. In this sense, characteristics are analyzed in cognitive profiles not as dichotomy but as probability values. This allows us to have more sensitive analyses and more realistic profiles. The profiles of 2 selected students are given in detail below.

Table 7. The 10th Student's Cognitive Profile

	CDV	CIV	SSL	TEI	TIM	INF	NEG	SUM	MCF	NON	ADJ	PRN	VRB	CON	SPP	T.Ch.	T.S.
Final Proficiency	0.29	0.17	0.01	0.04	0.02	0.70	0.24	0.02	0.03	0.03	0.03	0.02	0.06	0.03	0.05	1	7
Final	0.66	0.94	0.92	0.41	0.21	0.99	0.82	0.97	1.00	1.00	0.99	0.94	1.00	0.75	1.00	13	44

The development of the 10th student between the proficiency and final tests as well as his cognitive profile are seen in the table above. The student had 7 correct answers in the proficiency test while this number increased up to 44 in the final test. In addition, he only had the INF characteristic in the proficiency test while the number of characteristics possessed by him increased up to 13 in the final test. The student did not have the TEI and TIM characteristics in the final test profile. However, the probability that the student might possess the characteristic increased for both characteristics. An increase was occurred in the probability rates for all the characteristics in the period between the two tests.

Table 8. The 64th Student's Cognitive Profile

	CDV	CIV	SSL	TEI	TIM	INF	NEG	SUM	MCF	NON	ADJ	PRN	VRB	CON	SPP	T.Ch.	T.S.
Final Proficiency	1.00	0.99	1.00	0.86	0.11	0.37	0.96	0.94	0.91	0.91	0.96	0.99	0.92	0.50	0.83	13	29
Final	0.84	0.95	0.92	0.64	0.93	0.99	1.00	0.99	1.00	1.00	0.91	0.94	1.00	0.96	1.00	15	45

The 64th student's profile shows an increase in the number of correct answers and possessed characteristics from the proficiency test to the final test. Another advantage of the model used in the study is that it provides information about the levels of the possessed characteristics. Considering the development of the 64th student in the CON characteristic, it is seen that the student had the characteristic in both tests while the rate of possession got closer to 1.

4. Discussion

According to the results, the students had few characteristics in the proficiency test, but they increased in the final test. It is possible to say that the students acquired the characteristics required to be possessed during the English preparation education they received.

Another result of the study is that 50% of the students had the CON, NON, PRN, VRB, SPP, ADJ, SUM, and TIM characteristics in the final test while they had not had them in the proficiency test. Accordingly, the students had lacks regarding morphological knowledge at the beginning of the English preparation education. However, the students acquired these characteristics until the final test thanks to the richness of teaching methods, various materials, and the experience of lecturers.

According to the study results, CON is the characteristic of the highest level acquisition by the students in the period between the proficiency and final tests. This may be because conjunctions are the most important element for understanding sentences and comprehending the expressions and parts of sentences better by connecting them with one another.

Another result of the study indicates that the students started with the INF and NEG characteristics, as indicated by the results of the proficiency exam analyses. However, it is seen that the education they received improved the levels of these characteristics. Accordingly, the students already had skills of making deductions or accessing accurate or inaccurate information in English reading texts until they received English preparation education even if these skills were low-level. It is possible to say that intensive education program, effective learning environment, and constant opportunity to examine English reading texts helped the students to improve their reading skills, enhanced their competency of understanding what they read as well as the purpose of the writer, and allowed them to make deductions, accurately or not.

The study also revealed that TEI is the characteristic of the lowest level of acquisition among other 15 characteristics. In this sense, it is possible to say that the students have low levels of competency in the fast reading skill, which is necessary to infer a holistic meaning from a text based on the parts of the text. This may stem from lack of vocabulary, which leads them to spend more time to understand the text.

According to the study results, it is possible to say that cognitive profiles of students revealed via CDM offer profound insights into their strengths and weaknesses. Determining the cognitive profiles of individuals through an appropriate approach may provide important feedbacks regarding the quality of education.

1.15 skills that need to be given to students via foreign language education should be provided at maximum level through an effective education and richness of methods, and students should be equipped with basic language skills such as reading, listening, comprehension, writing, speaking and grammar.

2. Before foreign language education, students should acquire the basic language skills in their native languages in the first place. In order to make students acquire these four skills effectively, learning environments should be supported with the most efficient teaching materials.

3. According to the study results, students are able to improve their skills of recognizing and distinguishing conjunctions, nouns, pronouns, and verbs, which are about the morphological structure, as well as their summarization and selective reading skills at the highest levels. In this sense, more coverage may be given to the activities that will improve their reading skills.

4. TEI-Fast reading skill is the characteristic of the lowest-level acquisition by the students. Thus, activities which will equip students with the fast reading skill that will enable them to make associations within the text they read fast should be performed in the process of English education as a foreign language.

5. The study was conducted with prep school students studying English as a foreign language at Ege University. A similar study can be conducted with different groups of students having different characteristics and studying different languages.

6. Similar and richer studies can be carried out by taking the views of students studying English as a foreign language.

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