Analyzing Comments Made to The Duolingo Mobile Application with Topic Modeling

Mesut Polatgil[1]

[1]*Computer Science,Sivas Cumhuriyet University, Sivas, Turkey*

Abstract: There are approximately 6.4 billion mobile users in today's world. With this widespread use, people now prefer devices that are easier to carry and use, such as mobile devices. At this point, mobile applications play a very important role. Mobile applications are preferred for many purposes, especially for entertainment, education and social activities. In foreign language learning, there are hundreds of mobile applications that contain different activities for many foreign languages. Duolingo is an application that stands out in terms of providing many foreign language support and learning by gamification. Users of this application, which has such a widespread use, give feedback with their ratings and comments. More than one million comments have been left on the Duolingo app so far. This study was carried out in order to analyze these comments and to determine which points the users bring to the fore, and to provide preliminary information for both software developers and those who want to look for similar applications based on these points. The comments were analyzed by the Latent Dirichlet Allocation (LDA) method using the Python programming language and NLTK, Gensim libraries. The topics detected by both the word bag term frequency and the term frequency-inverse document frequency (TF-IDF) method are shown.

Keywords: Duolingo, Topic Modelling, Latent Dirichlet Allocation (LDA), Text mining.

1. INTRODUCTION

There are approximately 6.4 billion mobile users in today's world [1]. Considering that the world population is 7.9 billion, this shows that the rate of smartphone usage is over 80 percent [1]. Mobile applications are also a very important element at the point of use of mobile devices. These applications are also more easily accessible as they are in web-based distribution services such as the Google Play Store. In addition, these distribution systems play an important role in providing users with the opportunity to vote and convey their opinions. These comments can affect the success of the applications. In addition to these, there is a need to analyze this feedback information and to evaluate the results of the analysis [2].

Increasing usage rates of mobile devices also provide convenience in foreign language learning. Today, there are many applications and software for learning a foreign language such as Duolingo, Rosetta Stone, Memrise, Elsa Speak, Cake, British Council etc.

Duolingo is a software that stands out in terms of being free and allowing it to be used with mobile, tablet and computer. Duolingo also provides a learning environment for many languages that are widely spoken in the world,

such as English, Spanish, French and Turkish. In addition, it has reached approximately 11 million downloads on the Google Play Store so far. Researchers are investigating the effectiveness of these applications in foreign language learning. Ref [3], in their study with 9 participants, analyzed the users' work with Duolingo and examined their contribution to foreign language learning. As a result of the study, the participants found the gamification and flexibility of the Duolingo application positive. However, they also stated that their expectations about the variability in study motivation and teaching materials were not met. In the study in which Duolingo software was included in the A1 and B2 level course program for Spanish learning, they stated that the students liked Duolingo in terms of gamification and fun, and that the software could be included in the foreign language curriculum [4].In a study conducted with 10 participants in Tarakan, Borneo University for 30 days, it was seen that the use of Duolingo increased the test scores of the students, especially in terms of vocabulary [5]. In the study examining the studies between 2012 and 2020, it was stated that the studies gave more importance to the design of the tools, were quantitative and the results were generalized to other applications [6]. In the study conducted with 80 participants, mixed method was used and

as a result, it was emphasized that mobile assisted foreign language learning and applications could be included in foreign language learning [7]. In the study conducted with 75 people, it was determined that 84% of the participants learned English with mobile application and 64% of them worked with Duolingo [8]. Ref [9], examined the effect of Duolingo use on English vocabulary in their study and found that using Duolingo was very beneficial for English vocabulary learning. In the study conducted with 379 students, it was examined whether the students were willing to use Duolingo after a 14-week program [10]. In the study conducted with 60 university students using mixed method, they stated that the students developed a positive attitude towards the Duolingo program and that it was a useful and helpful program [11]. In the study conducted with 9th grade students, they determined that Duolingo software could be used to improve students' vocabulary [12].

Topic modeling is the process of uncovering hidden topics on text-based data. With this modeling, studies such as extracting document summaries, giving relevant answers to questions and sentiment analysis can be carried out [13]. In addition to showing which topics the documents are related to, the obtained topics also enable the extraction of the features of the documents and thus their use in processes such as finding document similarities [14]. Analyzing the comments on the tourism mobile application using the topic modeling method Use for third-party library recommendation systems along with collaborative filtering [15], in tagging mobile comments [16], in determining the reliability of applications from mobile application reviews in the field of health [17], the analysis of consumer attitudes towards organic foods [18], many studies have been carried out.

When the literature is examined, it is seen that sentiment analysis and topic modeling approaches are frequently used in relation to mobile applications. However, there is no study examining the comments regarding the Duolingo mobile software. This study was carried out in order to determine the important points emphasized by the users by modeling the comments made on the Duolingo application.

A. LATENT DRICHLET ALLACOTION (LDA)

Today, an important part of Natural Language Processing (NLP) applications is the detection of important topics from large text information. Because with the increase in the use of technology, there is an increase in the amount of text-based information. Much of this information comes from sources such as social media, e-mail, and product reviews. It is an important need to identify important topics from the text-based information that people give about a particular product or resource, and it increases the importance of topic modeling. Topic modeling approaches first emerged as Latent Semantic Analysis, which uses singular value decomposition of the document term matrix. The LDA model, on the other hand, provides a productive model

by obtaining the distribution of words in the topics and the distribution of the topics in the documents from the Dirichlet distribution [13]. The Dirichlet distribution is a generalization of the beta distribution for multi variables.

Topic modeling is a statistical method used to detect hidden content in documents. The main advantage of topic modeling is that it does not require documents to be tagged beforehand. Using the unsupervised learning method, it can determine which topics the documents are about. The most widely used method for topic modeling is the LDA method. As can be seen in Figure 1, with LDA, it is possible to obtain the words to which the topics are related and the probability values related to these words [19].
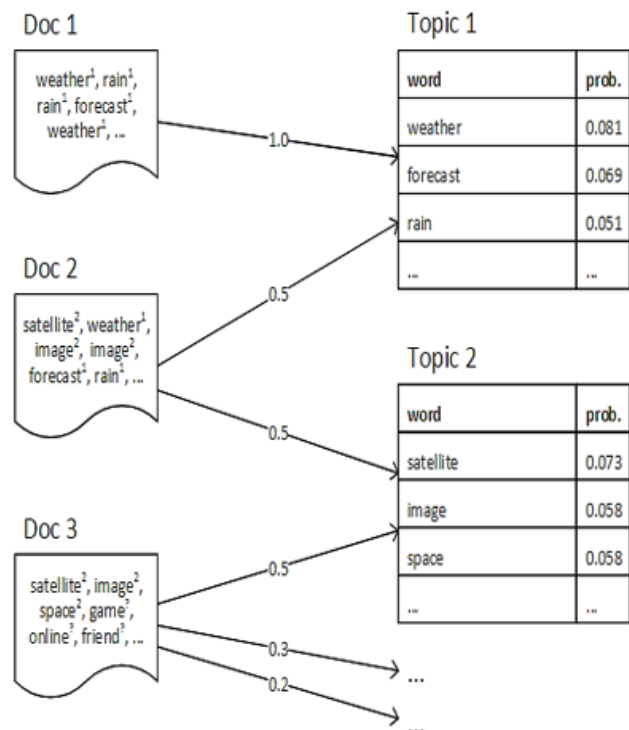

Figure 1. Topic Modelling

As seen in Figure 1, while the document named Doc 1 is only related to Topic 1, the document named Doc 2 is related to 50% Topic 1 and 50% Topic 2. The topics included here can be determined manually according to the words in the content.

The LDA algorithm also has a graphical representation. This notation, called plate notation, is given in Figure 2. D indicates the number of documents, N the number of words,

α the Dirichlet parameter for the document topic distribution, and β the Dirichlet parameter for the distribution of the topics over the words. Θ i, i document topic distribution and ϕ i,j, shows the word distribution for the k topic. probability equations and stages can be accessed from [18].
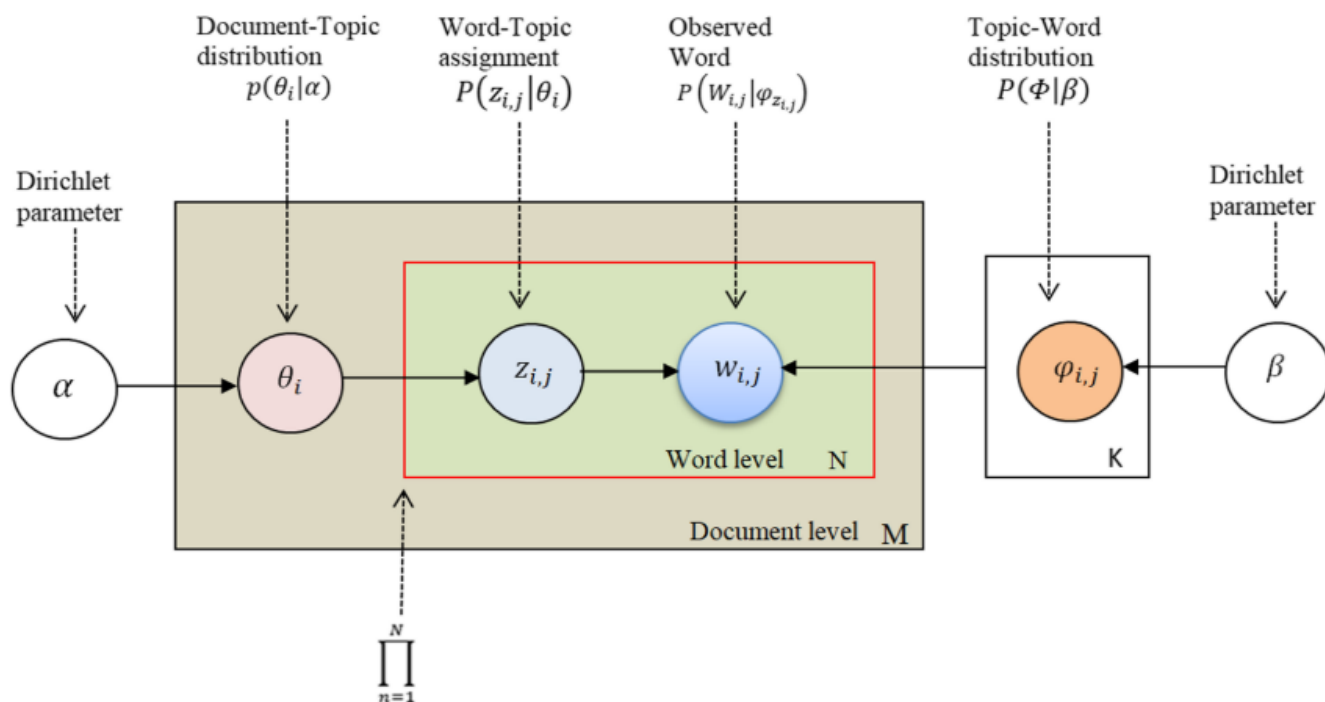
Figure 2. Plate notation for LDA

2. METHOD

In this study, Duolingo mobile application, which is the most common and most effective software in foreign language learning, was preferred [20]. In choosing it, the support it provides for many foreign languages, the number of downloads of more than 11 million, the number of comments over 1 million, as well as the fact that a lot of work has been done on it [6] were taken into account.

Topic modeling method, which is one of the natural language processing methods, was used for the analysis of the comments made to the Duolingo program [2]. Thus, it will be possible to determine which topics the users give feedback and the important factors in using the application.

Scraping was done using the Python language from the Google Play Store web page. The comments made and the points given for these comments were drawn and saved in the csv file. The number of rows and columns of the dataset detect using the Pandas library. A total of 1 million 65 thousand English comments for Duolingo software were taken as of 05.01.2022.

The obtained data was saved in csv file format and imported using Python language and Pandas Library.

A. Data Preprocessing

First, punctuation were removed from the data using the NLTK library. Then, the data was cleaned by removing stopwords that did not indicate any important data like a, and. Each comment has been converted to lowercase
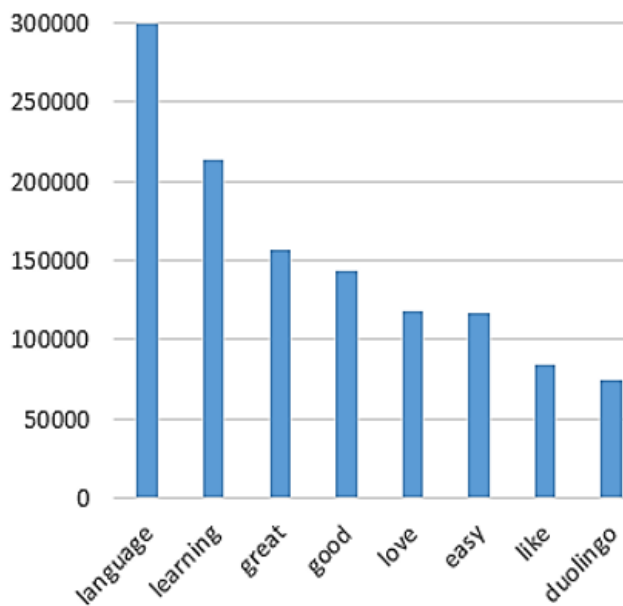

Figure 3. Most frequently repeated words

letters and tokenization. Tokenization was done with the Gensim Library "simple_preprocess" method. The data set was prepared by performing lemmatization of root finding for each word. The imported data set has been made ready for analysis. Dictionary was created with the Gensim library and the most frequently repeated words are shown in Figure

3.

As shown in Figure 3, it has been observed that users generally give feedback on language and learning in Corpus. An overview of all comments is provided before the topic modeling is done. Here, the most emphasized words by users are shown using only word frequency.

B. LDA Implementation
In this study, LDA was implemented with the Gensim library. Since the topic modeling studies use unsupervised learning method, the data set is not divided into training and testing. Therefore, an evaluation is not made as in classification and regression methods [21]. Therefore, the "coherence" value offered by the Gensim library was used for evaluation. The coherence score is a measure calculated based on the similarity of the words with the highest probability within the topics. This value should be as high as possible. The coherence score is calculated as shown in 1 (1) [22].

$$Coherence = \sum_{i<j} score\left(w_i, w_j\right)$$

$$Score\left(w_i, w_j\right) = \log\left(\frac{D\left(w_i, w_j\right) + 1}{D\left(w_i\right)}\right) \quad (1)$$

wi and wj shows words within the same topic, D(wi,˙wj), refers to the number of documents in which words occur together [22]. After calculating the coherence values for each topics, an overall coherence score is obtained by averaging all the values.

The number of topics to be determined is a value entered into the algorithm beforehand. To determine this value, the number of topics and coherence score graphs were drawn. Since the slowdown in the rate of increase was observed after the number of topics was 8 in the Figure 4, it was decided that it should be 8.
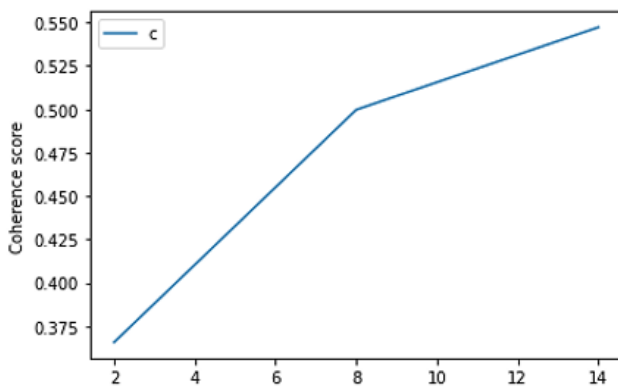

Figure 4. Coherence score chart with different topics numbers

3. FINDINGS
With the Gensim library, the entire corpus is first converted into a dictionary. The dictionary consists of approxi-

mately 109 thousand unique words in total. Coherence score is find 0.5195.

LDA analysis was used first with the bag of words method and then with the TF/IDF method.

The LDA was first made according to the word bag method and the frequency of words in the comments, and the results are given below.

Foreign Languages: 0.054*"spanish" + 0.030*"french" + 0.020*"time" + 0.020*"german" + 0.019*"using" + 0.017*"learned" + 0.017*"practice" + 0.015*"keep" + 0.015*"duolingo" + 0.015*"better"

Word and grammer 0.029*"word" + 0.020*"like" + 0.019*"would" + 0.015*"lesson" + 0.011*"thing" + 0.011*"grammar" + 0.010*"also" + 0.008*"make" + 0.008*"need" + 0.008*"could"

Simple and game 0.072*"like" + 0.051*"free" + 0.040*"well" + 0.037*"game" + 0.036*"tool" + 0.034*"simple" + 0.024*"make" + 0.023*"effective" + 0.022*"fantastic" + 0.019*"user"

Recommend 0.057*"highly" + 0.056*"helped")+ 0.043*"super" + 0.042*"fast" + 0.038*"recommended" + 0.030*"loved" + 0.027*"recommend" + 0.023*"para" + 0.021*"loving" + 0.017*"aprender"

Useful 0.092*"awesome" + 0.050*"useful" + 0.046*"would" + 0.041*"japanese" + 0.041*"please" + 0.026*"wish" + 0.025*"star" + 0.024*"like" + 0.022*"want" + 0.021*"could"

Perfect 0.198*"best" + 0.086*"excellent" + 0.079*"english" + 0.059*"ever" + 0.042*"apps" + 0.029*"free" + 0.029*"wonderful" + 0.024*"foreign" + 0.020*"used" + 0.018*"beginner"

Free and nice 0.050*"nice" + 0.028*"free" + 0.028*"none" + 0.024*"program" + 0.019*"lesson" + 0.017*"phone" + 0.016*"time" + 0.014*"keep" + 0.010*"duolingo" + 0.010*"even"

Helpfull 0.186*"really" + 0.071*"amazing" + 0.056*"helpful" + 0.045*"much" + 0.042*"duolingo" + 0.040*"help" + 0.039*"make" + 0.037*"thanks" + 0.032*"thank" + 0.028*"free"

The names given to the topics are showed in bold and the words and weight coefficients related to this topics are given next to the topics.

Later, the same analysis was applied with the TF-IDF method and the results are given in below.

Rosetta Stone 0.015*"practice" + 0.014*"keep" + 0.013*"cool" + 0.012*"spanish" + 0.012*"loved" + 0.011*"rosetta" + 0.011*"stone" + 0.010*"better" +

0.009*"well" + 0.009*"free"

Useful and helpful 0.079*"really" + 0.072*"helpful" + 0.060*"useful" + 0.048*"like" + 0.038*"spanish" + 0.035*"help" + 0.031*"fantastic" + 0.024*"french" + 0.018*"game" + 0.016*"helped"

Perfect 0.197*"awesome" + 0.119*"amazing" + 0.054*"perfect" + 0.031*"brilliant" + 0.024*"friendly" + 0.022*"work" + 0.019*"user" + 0.019*"excelente" + 0.013*"para" + 0.010*"aprender"

Many foreign language 0.019*"japanese" + 0.014*"would" + 0.013*"please" + 0.013*"wonderful" + 0.013*"english" + 0.012*"wish" + 0.010*"word" + 0.010*"need" + 0.010*"speak" + 0.010*"spanish"

Time and lessons 0.009*"time" + 0.008*"lesson" + 0.008*"would" + 0.008*"like" + 0.007*"free" + 0.007*"word" + 0.007*"star" + 0.006*"work" + 0.006*"thing" + 0.005*"make"

Effective and free 0.197*"best" + 0.067*"free" + 0.063*"ever" + 0.044*"application" + 0.041*"simple" + 0.034*"effective" + 0.032*"duolingo" + 0.032*"thank" + 0.030*"apps" + 0.027*"much"

Educational and pleasant 0.180*"excellent" + 0.177*"nice" + 0.077*"tool" + 0.062*"make" + 0.037*"program" + 0.028*"educational" + 0.027*"loving" + 0.017*"simply" + 0.012*"useful" + 0.010*"buena"

Recommendation 0.048*"none" + 0.035*"thanks" + 0.031*"recommend" + 0.030*"super" + 0.026*"addictive" + 0.022*"highly" + 0.021*"beginner" + 0.021*"fast" + 0.016*"recommended" + 0.016*"foreign"

In the topic modeling made with the TF/IDF method, there were differences compared to the BOW (Bag of Words) method, more prominently in some titles. The most striking difference is that the software called Rosetta Stone is expressed by users.

The comparison of TF/IDF and BOW methods in terms of Coherence and Perplexity scores is given in Figure 5.

Perplexity value shows the success of the model by making a general evaluation of the new data. It is desirable that this value be as small as possible. While calculating the value, the dataset was calculated by separating it with the 80-20

The names of the topics were given manually, taking into account the words belonging to the topics. Topic names are shown in bold. The topics and the most repeated words among these topics are given in Table I.

Table I shows that the most frequently repeated words are generally positive expressions about software, especially
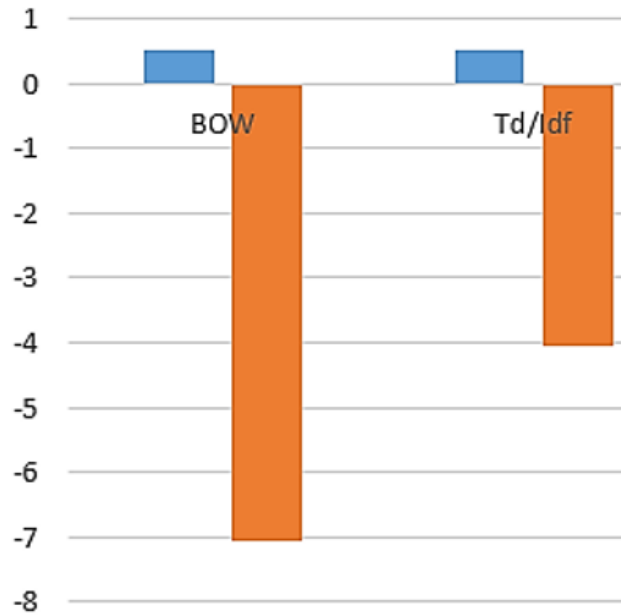

Figure 5. Coherence and Perplexity Score plot of BOW and TF/IDF methods

TABLE I. Words in more than one topic

Word	Number of topics
Fantastic-super-awesome	6
Love-like	4
Spanish	3
Free	2
Useful	2

Fantastic, super and awesome.

The topics are shown in Figiru 6 by using the pyLDAvis library to visualize the results obtained. Figure 6 is obtained by visualizing the document term frequency results.

When Figure 6 is examined, it is seen that the obtained topics generally overlap. Despite this, it has been determined that the topics 4, 6 and 8 differ from each other.

The visualization process was also applied with TF-IDF data and the results are given in Figure 7

When Figure 7 was examined, it was found that the topics generally overlapped. It can be seen that topics 4 and 8 differ from other topics.

The study findings show that the topic modeling results obtained from the document-frequency data are better than the results obtained from the TF-IDF data. Because it is ideal for the blue colored circles to be far from each other and large. However, in the TF/IDF method, it is seen that these blue circles overlap each other quite a lot.
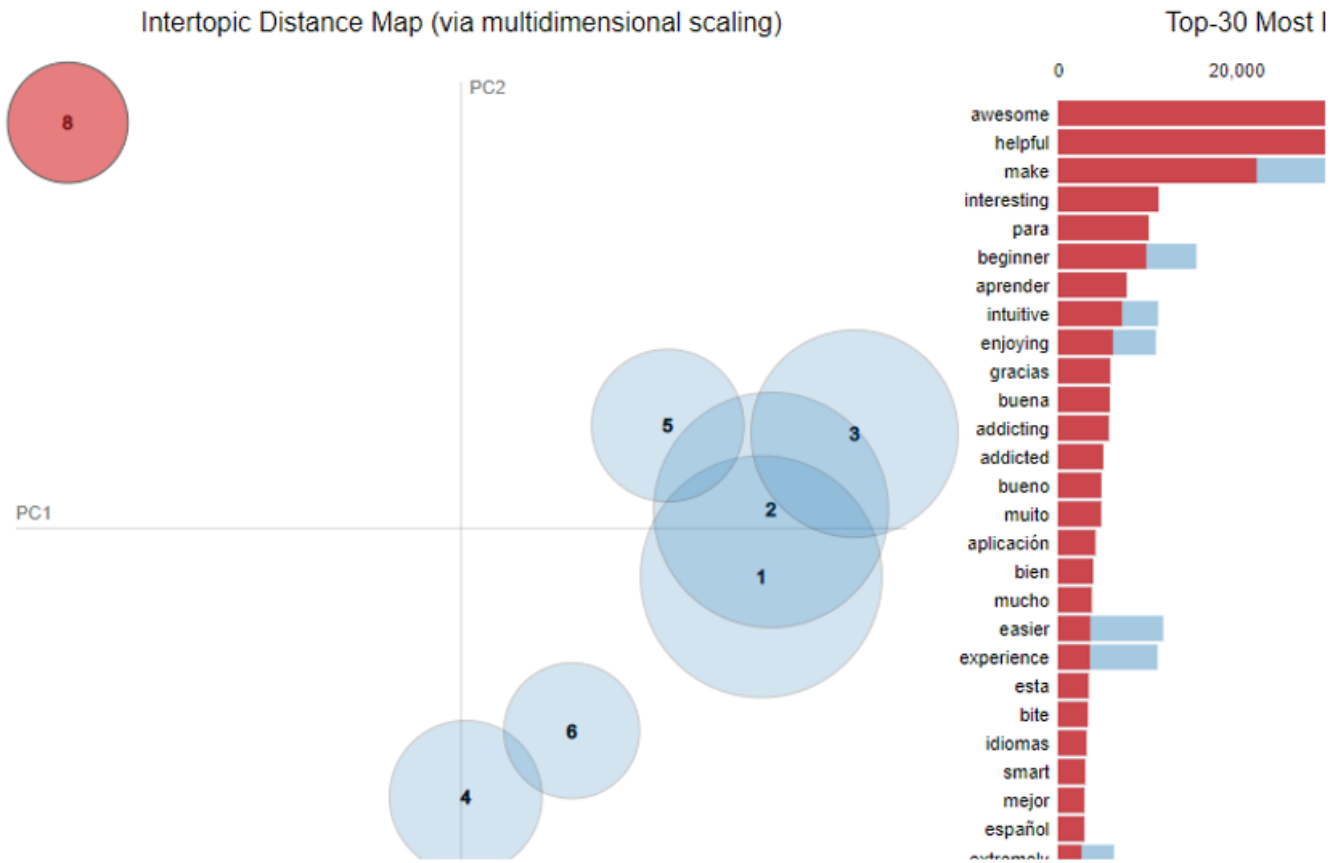
Figure 6. Visualization of document-term frequency topics by pyLDAvis library

4. DISCUSSION

In this study, comments made to Duolingo mobile software, which is widely used in foreign language learning, were analyzed by topic modeling. Thus, from the comments made, important topics highlighted by the users were determined.

In their study, in which they systematically examined the studies carried out between 2012 and 2020, they stated that the studies were design-oriented, quantitative and with non-probabilistic sampling [6]. In this study, the comments made to the Duolingo software were analyzed and it was revealed which topics the users emphasized the most. The study is a quantitative study with this aspect.

According to the results of the research, it is take place more than one topics to be useful. In addition, users described the Duolingo software with words such as perfect, awesome, and super. In the study conducted with 60 university students, the students' evaluation of the Duolingo program as a useful and helpful program is similar to the research results [11].

Study results show that Duolingo software users also highlight languages such as Spanish, English, French, and Japanese. Users care that the program supports many for-eign languages. These results are due to the fact that Spanish, English and Japanese languages are at the top of the list of most spoken languages in the world [23].

In the study, the users' emphasis on the help feature for Duolingo shows that the users care about the Duolingo software helping in foreign language learning. It is similar to [24], which investigates the benefits of mobile applications in foreign language learning with a literature review. In addition, users emphasized the words game and time and stated that the program provides a fun time by gamifying foreign language learning. The facilitating effectiveness of digital game-based software in foreign language learning has also been indicated through literature research [25].

It has been determined that the topic modeling obtained from the TF-IDF values gives worse results than the topic modeling obtained from the document-expression frequency data. It is thought that these results may occur when users use some words excessively in their comments. For example, the use of the word awesome in many comments may reduce the TF-IDF value, thus it is estimated that it may cause deterioration in the relations between the topics and the words.

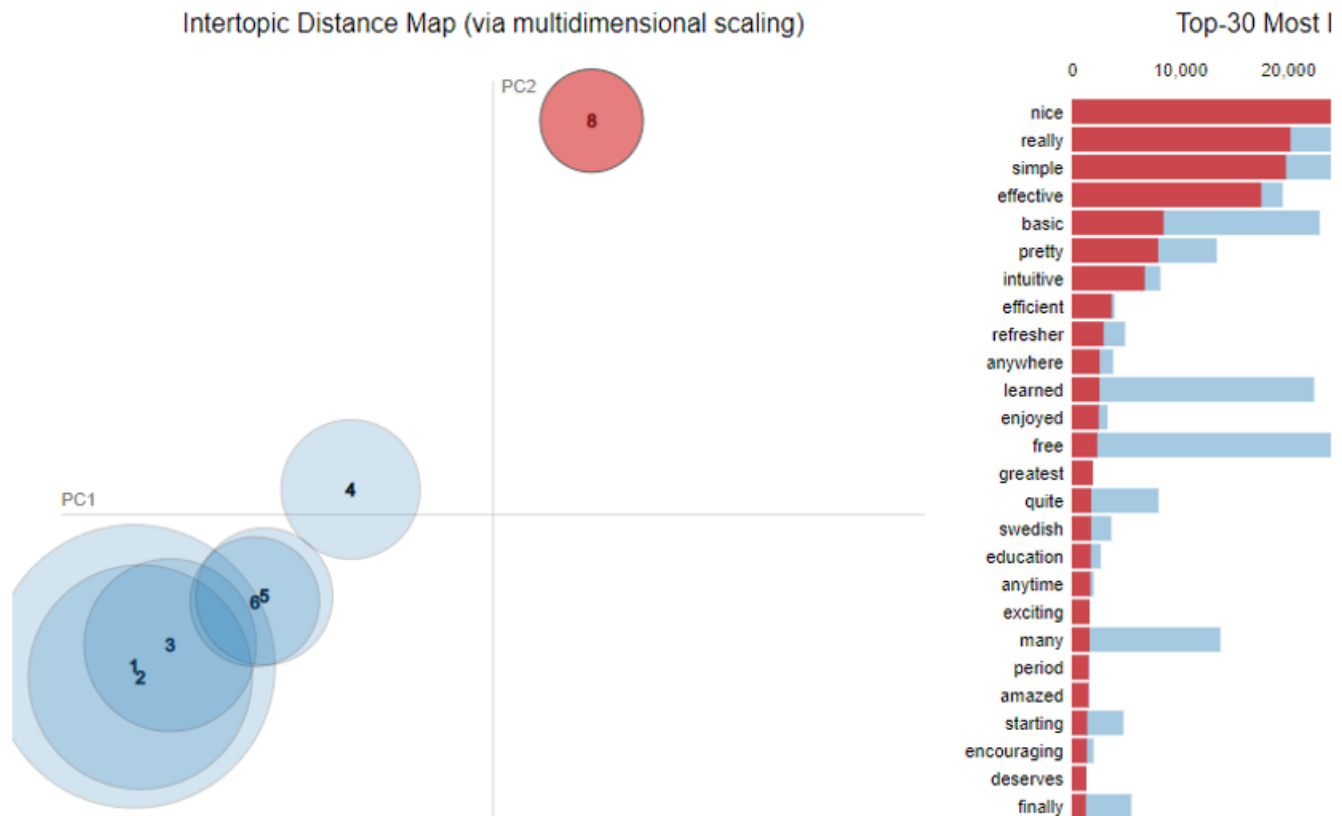Although the TF/IDF results are not good, it may

Figure 7. Visualization of document-tf/Idf topics by pyLDAvis library.

be important to detect Rosetta Stone software here. It is noteworthy that users mostly compare Duolingo with this software. The similarity of Duolingo and Rosetta Stone software may have played an important role in making this comparison. Because Rosetta Stone software is used in learning 25 different foreign languages and appeals to visual and auditory senses. Although there are studies on Rosetta Stone in the literature, it has been seen that there is no topic modeling study [26], [27].

5. CONCLUSION

The results of the research have shown that the Duolingo foreign language learning program is a very popular software by the users. Analysis of the comments made shows that users primarily evaluate the software's support for learning many foreign languages. The software's gamification of foreign language learning, its usefulness and its freeness were liked and emphasized by the users.

In future studies, studies can be carried out to analyze the comments made on the mobile application, which may be useful for application developers. The methods to be applied for these studies can be compared [2]. Analysis of comments can be made using semi-supervised methods [19].

By analyzing the comments made to the Rosetta Stone application determined from the study findings, similarities and differences with Duolingo can be determined. The evaluations of these two applications by the learners can be analyzed. In future studies, the topic models of these two applications can be made together to examine how much the topics differ or overlap with each other. In addition, what kind of different or similar features in applications can be analyzed technically. Recommendation systems can be developed for those who want to learn a foreign language by using these similarities or differences.

REFERENCES

[1] Statisca, "Number of smartphone users from 2016 to 2021," 2020. [Online]. Available: https://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/

[2] M. Tavakoli, L. Zhao, A. Heydari, and G. Nenadić, "Extracting useful software development information from mobile application reviews: A survey of intelligent mining techniques and tools," *Expert Systems with Applications*, vol. 113, pp. 186–199, 2018. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0957417418303361

[3] "Mobile-assisted language learning: A Duolingo case study," *ReCALL*, vol. 31, no. 3, pp. 293–311, 2019. [Online]. Available: https://www.cambridge.org/core/journals/recall/article/abs/mobileassisted-language-learning-a-duolingo-case-study/A4D7C8F71782A37D258C19F357DDBCBE

[4] P. Munday, "The case for using DUOLINGO as part of the lan-

guage classroom experience," *RIED: Revista Iberoamericana de Educación a Distancia*, vol. 19, no. 1, pp. 83–101, jan 2016.

[5] P. Ajisoko, "The Use of Duolingo Apps to Improve English Vocabulary Learning," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 15, no. 7, pp. 149–155, 2020.

[6] M. Shortt, S. Tilak, I. Kuznetcova, B. Martens, and B. Akinkuolie, "Gamification in mobile-assisted language learning: a systematic review of Duolingo literature from public release of 2012 to early 2020," *https://doi.org/10.1080/09588221.2021.1933540*, 2021. [Online]. Available: https://www.tandfonline.com/doi/abs/10.1080/09588221.2021.1933540

[7] K. Rebeca Finardi, R. Gomes Leão, and G. Brito Amorim, "Education and Linguistics Research Mobile Assisted Language Learning: Affordances and Limitations of Duolingo," vol. 2, no. 2, 2016.

[8] G. Kılıç, "Yabancı Dil Öğreniminde Kullanılan Etkileşimli Mobil Uygulamalar: Duolıngo Örneği," *Eğitim ve Öğretim Araştırmaları Dergisi*, vol. 5, no. 34, 2016.

[9] A. Irawan, A. Wilson, and S. Sutrisno, "The Implementation of Duolingo Mobile Application in English Vocabulary Learning," *Scope : Journal of English Language Teaching*, vol. 5, no. 1, pp. 08–14, nov 2020. [Online]. Available: https://journal.lppmunindra.ac.id/index.php/SCOPE/article/view/6568

[10] E. Ünal and F. Güngör, "The continuance intention of users toward mobile assisted language learning: The case of DuoLingo," *Asian Journal of Distance Education*, vol. 16, no. 2, p. 2021, dec 2021. [Online]. Available: http://www.asianjde.com/ojs/index.php/AsianJDE/article/view/589

[11] N. Inayah, Q. Yusuf, and N. Fibula, "Explorıng Undergraduate Students' Perceptıon Toward The Use Of Duolıngo In Learnıng Englısh," *Humanities Social Sciences Reviews*, vol. 8, no. 3, pp. 76–85, 2020. [Online]. Available: https://doi.org/10.18510/hssr.2020.83976%7Cwww.hssr.in

[12] F. M. Pacheco Díaz, "The duolingo app and the development of vocabulary skills in students of ninth-grade level of elementary school at Unidad Educativa Ambato," mar 2018. [Online]. Available: https://repositorio.uta.edu.ec:8443/jspui/handle/123456789/27371

[13] D. M. Blei, A. Y. Ng, and J. B. Edu, "Latent Dirichlet Allocation Michael I. Jordan," *Journal of Machine Learning Research*, vol. 3, pp. 993–1022, 2003.

[14] G. Aydin and R. Hallaç, "Türkçe Metinlerde Otomatik Konu Tespiti," *Fırat University Journal of Engineering Science*, vol. 33, no. 2, pp. 599–606, sep 2021. [Online]. Available: https://dergipark.org.tr/en/pub/fumbd/issue/64914/899917

[15] H. Yu, X. Xia, X. Zhao, and W. Qiu, "Combining collaborative filtering and topic modeling for more accurate android mobile app library recommendation," *ACM International Conference Proceeding Series*, vol. Part F130951, sep 2017. [Online]. Available: https://doi.org/10.1145/3131704.3131721

[16] A. Puspaningrum, D. Siahaan, and C. Fatichah, "Mobile app review labeling using lda similarity and term frequency-inverse cluster frequency (TF-ICF)," *Proceedings of 2018 10th International Conference on Information Technology and Electrical Engineering: Smart Technology for Better Society, ICITEE 2018*, pp. 365–370, nov 2018.

[17] D. Prashanth and S. Premaratne, "Reliability Analysis of Mobile Application Based on the User Reviews of Health and Fitness," *IJESC*, 2020.

[18] A. Singh and A. Glińska-Neweś, "Modeling the public attitude towards organic foods: a big data and text mining approach," *Journal of big data*, vol. 9, no. 1, p. 2, dec 2022. [Online]. Available: https://pubmed.ncbi.nlm.nih.gov/35013700/

[19] S. Vakulenko, O. Muller, and J. vom Brocke, "Enriching iTunes App Store Categories via Topic Modeling." in *Proceedings of the International Conference on Information Systems - Building a Better World through Information Systems, ICIS 2014, Auckland, New Zealand, December 14-17, 2014*, M. D. Myers and D. W. Straub, Eds.   Association for Information Systems, 2014.

[20] D. H. Center, "What is Duolingo?https://support.duolingo.com/hc/en-us/articles/204829090-What-is-Duolingo," 2020.

[21] Y. M. Lee, Y. Y. Soo, K. H. Gan, and N.-H. Samsudin, "A Text Analytics Approach to Study Python Questions Posted on Stack Overflow," *International Journal of Systematic Innovation*, vol. 6, no. 5, pp. 55–66, oct 2021. [Online]. Available: https://www.ijosi.org/index.php/IJOSI/article/view/469

[22] E. Ekinci and S. Omurca, "Ürün Özelliklerinin Konu Modelleme Yöntemi ile Çıkartılması," *TBV Journal of Computer Science and Engineering*, vol. 9, no. 1, pp. 51–58, jun 2017. [Online]. Available: https://dergipark.org.tr/en/pub/tbbmd/issue/30338/266158

[23] M. N. Ural and Ö. Tuna, "Kurumsal Sürdürülebilirliğin Dünyanın En Çok Konuşulan Dillerinde Çevrimiçi Görsel Algısı," *Mavi Atlas*, vol. 7, no. 2, pp. 220–242, oct 2019. [Online]. Available: https://dergipark.org.tr/en/pub/gumusmaviatlas/issue/49751/620704

[24] J. Kacetl and B. Klímová, "Use of Smartphone Applications in English Language Learning—A Challenge for Foreign Language Education," *Education Sciences 2019, Vol. 9, Page 179*, vol. 9, no. 3, p. 179, jul 2019. [Online]. Available: https://www.mdpi.com/2227-7102/9/3/179/htmhttps://www.mdpi.com/2227-7102/9/3/179

[25] H. T. Hung, J. C. Yang, G. J. Hwang, H. C. Chu, and C. C. Wang, "A scoping review of research on digital game-based language learning," *Computers Education*, vol. 126, pp. 89–104, nov 2018.

[26] G. Lord, "" i don't know how to use words in spanish":" rosetta stone" and learner proficiency outcomes," *The Modern Language Journal*, vol. 99, no. 2, pp. 401–405, 2015.

[27] ——, "Rosetta stone for language learning: An exploratory study," *IALLT Journal of Language Learning Technologies*, vol. 46, no. 1, pp. 1–35, 2016.

Mesut Polatgil Polatgil He is a lecturer in computer science in the Faculty of Applied Sciences. He received his Ph.D. degree in Numerical methods from the University of Sivas Cumhuriyet. He has more than 8 years of teaching and research experience in information systems development and machine learning. His research interests include machine learning, numerical methods and data science