A Classification Approach with Machine Learning Methods for Technical Problems of Distance Education: Turkey Example

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ABSTRACT

Distance education is an education model in which the lessons can be taught simultaneously using technical material without time and space restrictions. It has gained importance after the Covid-19 pandemic processes and has been implemented as a valid educational model in all educational institutions. Due to the sudden pandemic measures, distance education has brought about a lot of technical problems at unprepared educational institutions against the pandemic. In this paper, a classification approach is proposed by machine learning methods on Twitter instead of the usual structured research methods such as survey, one-on-one meeting for technical problems of distance education. The most encountered and commented distance education problem, which can be defined in different languages by the proposed method, have been analysed with Turkey example. Sentiment analysis has been made from negative and neutral tweets about distance education. The problems have been classified by natural language processing methods based on Turkish word analysis.

INTRODUCTION

Distance education is widely applied due to the Covid-19 global pandemic nowadays. Due to the global pandemic measures, many schools had to compulsorily pass to distance education. Distance education has gained more importance after the Covid-19 pandemic process all over the world and it has been implemented as a valid educational model in all educational institutions. All education institutions have been affected by the pandemic process and cancelled real-time education. While online education offers a non-physical learning environment to more participants, the participants have to come together in a narrow learning environment such as a classroom in face-to-face education (Duman, 1992). In this global crisis, UNESCO has suggested distance education and online learning platforms for student-teacher interaction away from a pandemic threat at closed schools due to the global pandemic (Fatoni et al., 2020). Schrager (2020) claims that a specific-hybrid learning model will become permanent in life according to the education requirements after the Covid-19 period. Schrager (2020) also defends that the problems such as future infectious diseases, war, regional conflicts, and other types of natural disasters can restrict real-time education again.

Many schools and universities have started distance education in order not to interrupt education. The online learning environments have been quickly prepared for continuity of education by the education institutions (Koç, 2021). All institutions have started to research quality virtual learning environments in terms of hardware and software due to the Covid-19 pandemic concern. According to Çekerol (2020), online learning environments are web-based platforms that provide to follow, manage and teach the courses in distance education. These platforms present interactive learning facilities by their online features such as blackboards, chat rooms, surveys, online exams, discussion forums. During the pandemic period, the most widely used online learning environments in different countries are Microsoft Teams, Google Meet, Zoom, Skype, Adobe Connect, and similar others (Mukhtar et al., 2020; Petryshen et al., 2020). While the virtual learning environments have been used by educators that teach different science branches, these educators have to also learn and use technological materials that they have not experienced before (Kurnaz et al., 2020). Due to the sudden pandemic measures, the distance educational model has brought about a lot of problems at education institutions that were unprepared against the pandemic (Baaran et al., 2020). According to Dietrich et al. (2020), many educators had to lecture in less time at distance education due to technical problems such as insufficient bandwidth and file upload limits. Moreover, according to Baran (2020) the assessment and evaluation are other important distance education problems at online exams. As it is specified in current literature, technical problems of distance education should be solved for quality interactive education.

The aim of the study is to determine of the distance education problems quickly with machine learning methods on Twitter instead of the usual methods such as surveys, one-on-one meetings and to find a solution of the distance education problems. In this study, Turkish tweets are used with Turkey example but the proposed method will contribute a solution of distance education problems by optimizing different problem categories based on other languages. Moreover, the study will provide permanent solutions for distance educations problems by making a fast scan on social media. Thanks to a fast scan, precautions can be taken before for the categorized problems.

LITERATURE REVIEW

Distance education is an educational model that provides more participants for courses. All participants can participate in the courses from different locations thank online learning environments. Due to the global pandemic, most students have to attend courses via online environments in recent years. Although distance education has a lot of advantages for learning, it has also a lot of disadvantages such as technical infrastructure, momentary synchronization, exam problem, and the inadequacy of experiments in technical sciences.

Many researches have been made about distance education, especially during the pandemic period and last decades, with structured research methods such as surveys, one-on-one meetings, and social experiments. The distance education problems were categorized and defined by making a literature review in another study that was performed in 2011 on teachers and students in different locations (Rashid & Rashid, 2012). Fojtik (2018) has performed a

comparative study by analysing undergraduate students who took courses and studied in the computer science department with the distance education and full-time education model in the last two decades.

Research on distance education has increased in the last 2 years with the impact of the Covid-19 pandemic. The validity and reliability of emergency online classes were examined from the perspective of students and teachers, based on the qualitative data of the survey study taken from the Chinese University of Hong Kong at the time the pandemic measures were suddenly launched in China where the epidemic started (Xiao & He, 2020). Pete and Soko (2020) have been researched digital competence, cost, and Internet connection of distance education during the Covid-19 pandemic period in a structured survey of students and teachers that are selected sub-Saharan African countries, Kenya, Ghana, and South Africa. Sözen (2020) specified that a lot of research is made on distance education with the written and visual media in European countries that are especially affected by the pandemic.

On the other hand, many kinds of research have been realized for distance education as the other countries in Turkey. The distance education applications of higher education institutions during the pandemic period have been examined by considering the Covid-19 period activity reports that are prepared by the Turkish Higher Education Council (YÖK) (Yavuz et al., 2020). A group of researchers from Antalya AKEV University has performed research for determining to opinions of the university students and academicians on distance education by creating online survey questions with the structured interview method (Şen & Kızılcalıolu, 2020). In other research, Yılmaz and Güner (2020) have investigated distance education that is performed for different level students by considering parental opinions.

Instead of research of only educator and student problems, the problems of all education partners should be investigated in the pandemic period, which in its turn has influenced all social life. It is determined that the most basic meeting point that expresses problems in the pandemic period, which affects all family members, is social media. According to Keskin and Kaya (2020), people of all ages and classes of society have shared their opinions on social media about distance education in the pandemic period. Albayrak (2017) has specified that many people use social media by adding their sentiments and life experiences. Thus, social media researches provide more realistic and accurate data for the researchers (Matoševi & Bevanda, 2020). Social media analysis led to the idea of analysing and classifying a comment related to distance education problems.

Twitter is a social media platform used by all ages and walks of society all over the world. It presents its users most spoken topics which are based on user comments called trend topic. In recent years, a number of studies based on sentiment analysis have been made on Twitter about different topics. Özoran (2020) researched the usage of the 10 most valuable brands of Turkey in the Covid-19 pandemic period on Twitter. In the first 2 months of the pandemic, the most commented posts and most liked categories were investigated on 510 tweets by using quantitative and qualitative content analysis methods in the study (Özoran, 2020). In other study, Mandloi and Patel (2020) compared machine learning methods by Twitter sentiment analysis. They investigated different classification algorithms on sentiment analysis and analysed the accuracy and precision of the algorithms.

According to the research of Günçe and Carus (2020), sentiment analysis became an effective solution for different fields such as marketing, education, politics, and business in recent years. A social media user, which sincerely explains her/his opinions and emotions, helps and affects the other social media users. By this way, a social media metadata becomes a measurable data for sentiment analysis. The people intensely used social media and made a lot of comments on different topics during the pandemic period. One of the most based topics also became distance education among Twitter users in this period. Even if the education level of Twitter users is unknown, it is observed that Twitter is mostly used among educators, university students, academicians, and student parents. In this study, the Turkish "distance education" hashtags in the pandemic period are investigated and a classification approach is proposed for technical problems of distance education by machine learning methods. Additionally, EBA (Turkish Education Information Technology Network) System, which is an education information network for primary and secondary education levels in Turkey, has been also investigated. All technical problems except EBA are the common problems for each education level (primary-secondary-higher education) in the study.

MATERIALS AND METHODS

In our study, the Turkish tweets on distance education of the Twitter users are examined and a classification approach based on sentiment analysis is proposed for detection of distance education problems.

Initially, tweet data are handled as metadata and the tweet text is extracted from the metadata. The tweet text is also simplified from hashtags, mentions, web addresses and punctuations. Secondly the Turkish tweets are translated to English language for the sentiment analysis. Sentiment analysis is a natural language processing method that predicts which of the three main emotions expressed as positive, negative or neutral in a text (Dhawan et al., 2019; Prakruthi et al., 2018). The accuracy of the metrics is calculated with Stochastic Gradient Descent (SGD) algorithm for decreasing to translation errors (Huda et al., 2019). While the positive tweets are ignored for the distance education problems, the negative and neutral tweets are considered for the problem classification. Finally, text analysis is made for the classification of the original negative and neutral Turkish tweets. Basically, the classification steps based on machine learning methods are shown in *Figure 1*. Additionally, the Twitter APIs that are connected to Twitter developer account has been used for receiving tweet metadata. The problems have been categorized into 8 categories by Python deep learning libraries that are well known in natural language processing as nltk and sklearn. Each tweet text is evaluated one by one and sentiment analysis on tweet text is also handled as positive, negative, and neutral. The categories are determined by word classifiers defined before.
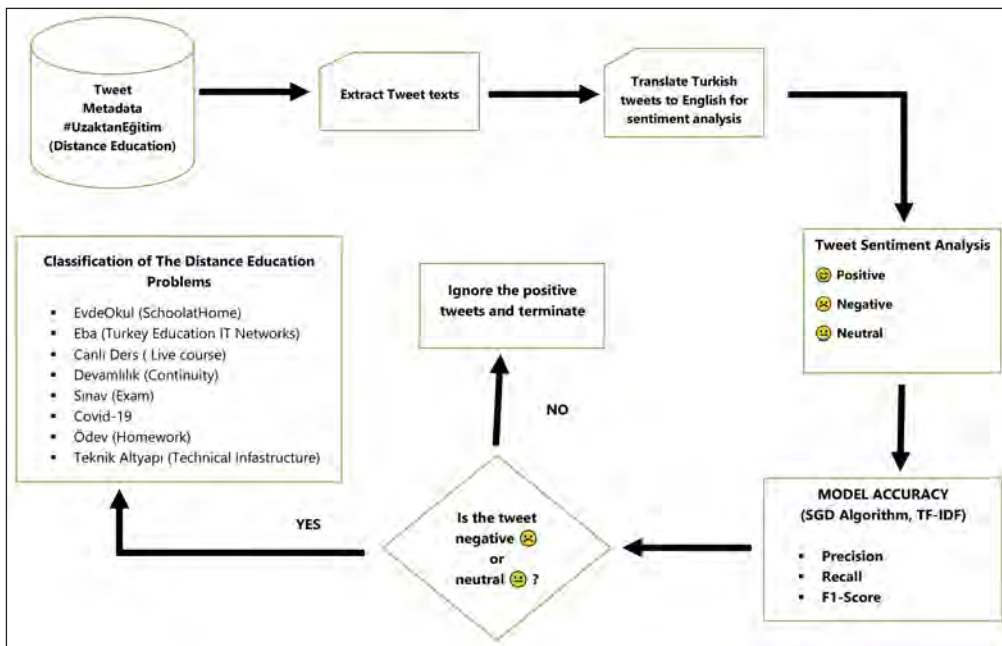

Figure 1 Classification steps.

FEATURE EXTRACTION

Each tweet on Twitter does not completely reflect distance education problems. Feature extraction aims for high-quality sentiment classification by reducing the multi-dimensionality of the tweet dataset by removing irrelevant features for the sentiment analysis. Term Frequency – Inverse Document Frequency (TF-IDF) is a calculated weight factor of a word that shows the importance in a text by using a statistical method (Umair et al., 2020). TF-IDF determines which sentiment the Twitter users write their opinions about distance education. If the user writes a negative or neutral tweet, the tweet is accepted to reflect the distance education problems as a hypothesis in our study. TF-IDF is used for simplifying of tweet texts and categorization. TF-IDF weights are calculated as Equation 1 (Kabir et al., 2015).

$$weight_{w,t} = \begin{cases} \log(tf_{w,T}+1)\log\dfrac{n}{x_w} \Rightarrow f_{w,T} \geq 1 \\ 0 \Rightarrow otherwise \end{cases} \quad (1)$$

$tf_{w,t}$ represents the frequency of word w in tweet T, n represents the number of tweets in "#UzaktanEğitim" ("#DistanceEducation") Turkish hashtags and x_w represents the number of tweets where word w includes.

STOCHASTIC GRADIENT DESCENT

Stochastic Gradient Descent (SGD) is a fundamental machine learning approach which can be applied to large-scale and diluted machine learning problems frequently encountered in text classification and natural language processing (Huda et al., 2019). SGD is a good optimization algorithm by ease of application and its productivity. The advantage of SGD is to update each sample in each step by decreasing optimization calculations, especially in big datasets. SGD refers to calculating the derivative from each training data and updating immediately (Alsadi et al., 2019).

SGD algorithm is used for sentiment analysis based on the TF-IDF weight factor, in our study. The emotions are extracted by SDG as a sentiment classifier and the positive, negative and neutral tweets are determined. Finally, the negative and neutral tweets are used for the problem categories on distance education.

EVALUATION OF THE MODEL

The proposed model has been evaluated with the standard metrics that are called accuracy, precision, recall and F1-score. TP is true positive, TN is true negative, FP is false positive, and FN is a false negative for calculations of the standard metric.

Accuracy is the most commonly used metric to evaluate how well the machine learning model is doing (Minab et al. 2015). Accuracy is a statistical measure which is defined as the division of the correct predictions (TP & TN) made by a classifier divided by the sum of all predictions made by the classifier, including FP and FN. The accuracy is computed as shown Equation 2.

$$accuracy = \frac{TP + TN}{TP + TN + FP + FN} \tag{2}$$

Precision is defined as the ratio of the correctly identified positive cases in all the predicted positive cases and it is shown as Equation 3 (Kabir et al., 2015).

$$precision = \frac{TP}{TP + FP} \tag{3}$$

Recall is the sensitivity of the model and it is defined as the ratio of the correctly identified positive cases to all the actual positive cases, which is the sum of FN and TP. Recall is also shown as Equation 4 (Kabir et al., 2015).

$$recall = \frac{TP}{TP + FN} \tag{4}$$

F1 Score is the harmonic meaning of the precision and recalled by taking into FP and FN cases. It shows a good performance in an unbalanced data set. It is calculated as Equation 5 (Kabir et al., 2015).

$$F_1 Score = \frac{2 \times (precision \times recall)}{(precision + recall)} \tag{5}$$

FINDINGS

SENTIMENT ANALYSIS

Sentiment analysis based on tweet text is initially required because each comment on social media does not completely reflect distance education problems. In this study, the 5000 tweet texts posted with "UzaktanEğitim" (DistanceEducation) Turkish hashtag on Twitter between March 2020 and December 2020, when pandemic cases were intense, were examined and sentiment analysis based on each text was first made (Trt Eba, 2020). During the pandemic period, the negative and neutral tweet texts were handled about distance education on Twitter.

As a hypothesis, the negative and neutral tweets have been assumed to reflect distance education problems. The most posted problems have been divided into 8 categories from these tweets. In addition, the data received as metadata on Twitter are separated into elements and the only tweet texts are researched by separating the unnecessary components such as tweet id, username, tweet data for this study. Moreover, the symbols such as hashtag, links, mention, punctuations on tweet texts are simplified and tweet text is analysed as a full text. Thanks to the simplification process, it is aimed to make a fully realistic sentiment analysis in tweet texts. The reactions of Twitter users about distance education are shown in *Figure 2*. According to the *Figure 2*, the Twitter users thought about distance education as positive 38.63 %, neutral 47.88% and negative 13.50%. Because the scarcity of the negative sentiment percent stem from the translation diversity, the neutral and negative tweets are examined together for reducing semantic errors.
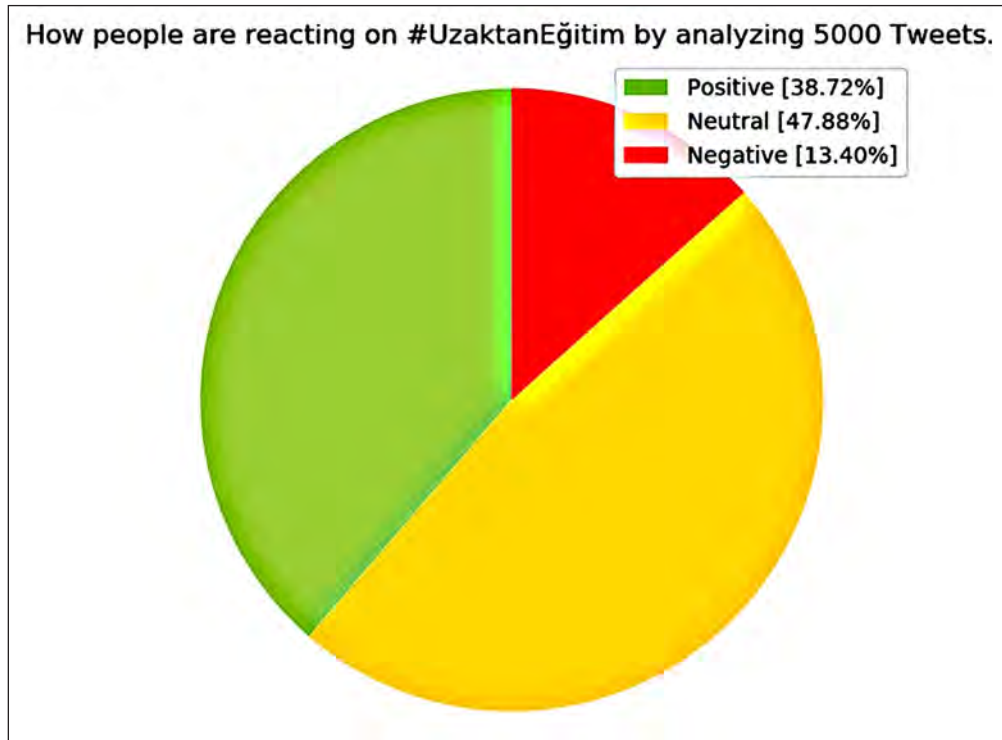

Figure 2 Sentiment analysis on #UzaktanEğitim (#DistanceEducation).

TWEET ANALYSIS

When the Turkish tweet analysis is investigated in our study, the most encountered problem in education is non-real-time education with 33.9 %. Following this problem, the most encountered problem is EBA system that is conducted online educational activities in Turkey by 28,3%. Another problem by 12.4% is the difficulty of accessing live courses in distance education. Additionally, Twitter users think that education in schools is not continuous due to the lack of educators (9.7%) and exams cannot be performed transparently (7.5%). Moreover, some users specified general complaints related pandemic period (4%). The other complaints are also homework problems (2.9%) and technical infrastructure (1.4%). Since the education level of Twitter users is unknown, all problems (except EBA system) are common problems for all education levels. On the other hand, it is predicted that the detected problems of the study are mostly related to higher education level when the words of Tweet texts are investigated such as campus, rector, professor, assistant, e-campus, etc. in the study. The obtained results are shown in *Figure 3*.

PROBLEM CATEGORIES

When the other researches on distance education are examined, the most observed problems are categorized. Tweet comments are determined to belong in which category by using the most frequent words in our study. In this study, the distance education problems based on Turkish word are determined as "Eğitim Bilişim Ağı (EBA)" (Turkey education IT network), "canlı
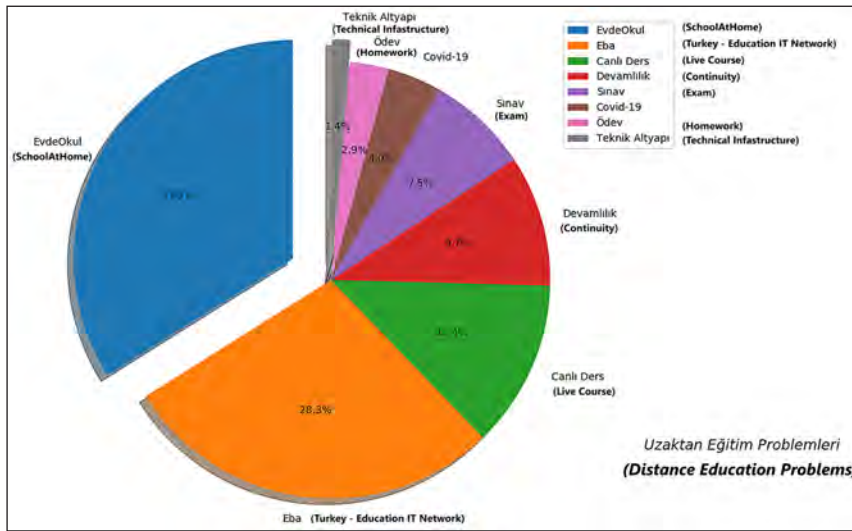
Figure 3 Distance education problems.

ders" (live course), "evde okul" (SchoolatHome), "Covid – 19", "sınav" (exam), "devamlılık" (continuity), "teknik alt yapı" (technical infastructure) and "ödev" (homework). All tweet comments were investigated with these categories and a graph based on the frequency of the problems is created for each category. Additionally, the other Turkish expressions related to category names have been also considered in tweet texts. The all Turkish words searched on tweet texts are shown in *Table 1* and the problem categories are also shown in *Figure 4*.

TURKISH CLASS NAME	SEARCHED TURKISH WORDS	FREQUENCY	PERCENTAGE
EvdeOkul *(SchoolatHome)*	Okul *(school)* , ev *(home)*	5032037	33.9%
Eba *(Turkey education IT network)*	Eba *(Turkey education IT network)*	4189209	28.3%
Canlı Ders *(Live Course)*	canlı *(live)*, canli *(live)*, zoom, teams, yüzyüze *(face to face)*, yuzyuze *(face to face)*, toplantı *(meeting)*, toplanti *(meeting)*, kulaklık *(headset)*, mikrofon *(microphone)*, chat, sohbet *(chat)*, oda *(room)*, online	1836696	12.4%
Devamlılık *(Continuity)*	Ders *(course)*, devam *(continue)*, zorunlu *(mandatory)* , yuzyuze *(face to face)*, yüzyüze *(face to face)*	1439217	9.7%
Sınav *(Exam)*	Sinav *(exam)*, sınav *(exam)*, not *(score)*, ortalama *(average)*, vize *(midterm)*, final, but *(make-up)*, büt *(make-up)*, karne *(school report)*, eit *(equal)*, koul *(condition)*, bütünleme *(make-up)*	1108046	7.5%
Covid-19	Pandemi *(pandemic)*, covid, salgın *(pandemic)*,salgin *(pandemic)*, küresel *(global)*, virüs *(virus)*, virüs *(virus)*, coronavirus, Covid-19	592458	4.0%
Ödev *(Homework)*	Odev *(homework)*, ödev *(homework)*, moodle, yükle *(upload)* , proje *(project)*	426022	2.9%
Teknik Altyapı *(Technical Infastructure)*	Baglanti *(connection)*, baglantı *(connection)*, bilgisayar *(computer)*, telefon *(phone)*, hata *(error)*, error, sistem *(system)*, internet, eriim *(access)*, altyapı *(infastructure)*, altyapi *(infastructure)*, teknik *(technic)*	202541	1.4%

Table 1 Frequencies of the searched words for defined problem classes (categories).
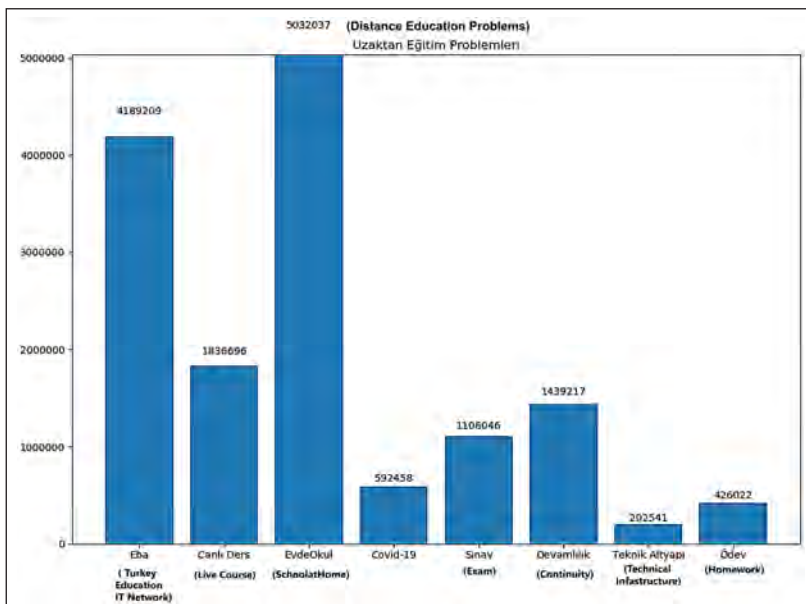

Figure 4 Problem categories.

An example Turkish tweet is as follow:

Turkish Tweet text:

"Covid-19 pandemi sürecinde canlı derslerin verimsizliği nedeniyle sınavlarımızın yüzyüze yapılmasını istiyoruz. #UzaktanEğitim"

English Translate:

("During the Covid-19 pandemic, we want our exams to be held face to face due to the inefficiency of live courses. #DistanceEducation")

In this study,

"Covid-19" and "pandemi" (pandemic) words will be belong to "Covid-19" class,

"canlı" (live), "ders" (course) and "yüzyüze" (face-to-face) words will be belong to "canlı ders" (live course) class,

"sınavlarımız" (exams) word will be belong to "sınav" (exam) class.

By this way, it is determined how often the problem is identified as each category in the tweet texts. Some words can be related with two or more classes such as "yüzyüze" (face-to-face) word in "canlı ders" (live course) and "devamlılık" (continuity) classes. These words are simultaneously inserted into two or more classes. For example, "sınavlar" (exams) word will belong to "sınav" (exam) class by extracting of word root. The searched words are considered within the relevant classes that are previously defined. The searched words, which are shown frequencies in *Table 1*, can be also increased with different relevant words. The most commented words have been considered in distance education in this study.

EVALUATION METRICS AND PERFORMANCE

In the study, the sentiment analysis based on SGD has been evaluated with standard metrics called recision, recall, F1 score. In our study, the tweet texts that have the negative or neutral polarity have been examined together for problem detection and the accuracy of the classifier has been calculated as 90%. The performance accuracies are shown in *Table 2*.

	PRECISION	RECALL	F1-SCORE	SUPPORT
0 (negative & neutral)	0,92	0,91	0,92	306
1 (positive)	0,86	0,88	0,87	190
Model accuracy			0,90	496
Macro avg	0,89	0,89	0,89	496
Weighted avg	0,90	0,90	0,90	496

Table 2 The accuracy of the sentiment analysis model.

According to the *Table 2*, the weighted average is weights of the performance metrics (0 and 1) and the macro average is an average of the performance metrics without weights. The support is the number of actual problem classes in the tweet texts.

RESULTS AND CONCLUSION

According to sudden Covid-19 pandemic measures, distance education played an important role in all the educational institutions in recent years. The identified distance education problems caused to search for permanent solutions for the educators and students. Because the educator and students suffer from the technical problems of distance education, a valid education is still not completely possible under Covid-19 pandemic measures in many countries. If the problems are categorized for all education partners, solution detection will be easy for distance education problems at crisis times. These problems should be quickly solved for high-quality education.

In our study, a classification approach is proposed based on machine learning techniques with twitter data for the technical problems of distance education. Many people cannot completely

express their opinions in a structured qualitative research that is multiple choice and non-dynamic questions. Because of the fact that some people quickly complete an online survey without reading, these kinds of methods cannot completely reflect the accuracy of the research. Instead of the structured qualitative research methods such as optional survey questions, sentiment analysis methods based on user's comments are developed by the development of social media analysis in recent years. Because Twitter allows tweet analysis for developers, the sentiment analysis based on text is easier on Twitter. Twitter allows tweet analysis for developers, so the sentiment analysis based on text is easier on Twitter. Moreover, people express their opinions by adding their emotions owing to the fact that social media comments are made voluntarily.

When the obtained data has been investigated from this study, it has been observed that distance education problems are more realistic and transparent problems on Twitter. The social media analysis will help educators and technical infrastructure providers, owing to sentiment analysis based on the machine learning algorithm is made with negative or neutral tweets in this study. Instead of the standard and closed-to-comment surveys prepared with the structured interview method, the transparent analysis on social media provides a convenience for the solution of distance education problems. Moreover, the proposed method will contribute to other education problems by means of analyzing similar comments.

On the other hand, a prototype study is proposed with Turkish tweet texts that express distance education problems in this study. The prototype model can be also extended for other languages by creating problem categories in different languages thanks to the proposed method. Additionally, a lot of researches are also made in different fields such as commerce, academic, health, and education due to pandemic measures. The permanent solutions are searched on social media by classifying the problems with machine learning techniques in recent years.

Thanks to social media analyses, a lot of problems can be solved based on user comments. In our study, the problem categories are determined by investigating the literature researches. This study can be also expanded for real-time social media analysis. In addition, more categories can be also added by determining the related words of each category. The proposed method not only helps resolve the education problems, but it can also provide a solution for the problem of other fields such as commerce, health, and business.

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COMPETING INTERESTS

The authors have no competing interests to declare.

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