Bitlis Eren Üniversitesi Sosyal Bilimler Enstitüsü Dergisi / *Journal of Bitlis Eren University Institute of Social Sciences* • Cilt/*Volume:* 7 • Sayı/*Number*:1 • Haziran/*June* 2018• ss. 286-297.

Araştırma Makalesi / *Research Article*
Geliş Tarihi / *Received*: 09.01.2018 • Kabul Tarihi / *Accepted*:19.03.2018

A Study of Technologies Used in Learning Management Systems and Evaluation of New Trend Algorithms

Zafer CÖMERT
Asst. Prof.
Bitlis Eren University-Department of Computer Engineering-Bitlis-Turkey
ORCID: 0000-0001-5256-7648
comertzafer@gmail.com

Özge CÖMERT
Lecture
Bitlis Eren University, Department of Social Services and Counseling-Bitlis-Turkey
0000-0001-7419-1848
okervan@beu.edu.tr

Abstract

Distance education is a completely different way of learning, separated from traditional face-to-face education, independent of time and place. The journey of distance education that started with communication tools such as letters, radio, and television continues to evolve based on the use of web-based technologies such as social media and learning management systems (LMSs), depending on the developments in technology today. In this study, a review has been carried out to outline the technologies used in LMS, first. In particular, the developments of the widely used advanced algorithms and LMSs have been taken into consideration in the study by examining web based technologies and standards. Then, an investigation on new trends algorithms in this field has been performed. In this scope, five supervised (linear regression, logistic regression, *k*-nearest neighbors, decision tree and Naïve Bayes), two unsupervised (Apriori and principal component analysis) and lastly one ensemble learning algorithm (Adaptive Boosting) have been examined. Consequently, the new algorithms have been proposed to be used in LMSs for different purposes, such as analyzing of users' hidden behaviors, performance prediction, producing automatic recommendations as well.

Keywords: Distance Education, Web Technologies, Learning Management Systems, Algorithms.

Öğrenme Yönetim Sistemlerinde Kullanılan Teknolojiler Üzerine Bir İnceleme ve Yeni Algoritmaların Değerlendirilmesi

Öz

Uzaktan eğitim, geleneksel yüz yüze eğitimden, zaman ve mekândan bağımsız olarak ayrılan öğrenmenin tamamen farklı bir yoludur. Mektup, radyo ve televizyon gibi iletişim araçlarıyla başlayan uzaktan eğitim yolculuğu, günümüzde teknolojideki gelişmelere bağlı olarak sosyal medya ve öğrenme yönetim sistemleri (ÖYS) gibi web tabanlı teknolojilerin kullanımına dayalı olarak gelişimini sürdürmektedir. Bu çalışmada öncelikle ÖYS'de kullanılan teknolojileri incelemek üzere bir derleme gerçekleştirilmiştir. Özellikle, web tabanlı teknolojiler ve standartların incelemesiyle, yaygın olarak kullanılan gelişmiş algoritma ve ÖYS'lerin gelişimi dikkate alınmıştır. Daha sonra, bu alandaki yeni trend algoritmalar üzerinde bir inceleme yapılmıştır. Bu kapsamda, beş denetimli öğrenme (doğrusal regresyon, lojistik regresyon, k-en yakın komşu, karar ağacı ve Naive Bayes), iki denetimsiz öğrenme (Apriori ve temel bileşen analizi) ve bir topluluk öğrenme algoritması (Adaboots) incelenmiştir. Sonuç olarak, yeni trend algoritmaların ÖYS'lerde, kullanıcıların gizli davranışlarını keşfetme, performans tahmini, otomatik öneriler üretme gibi amaçlar için kullanılması önerilmiştir.

Anahtar Sözcükler: Uzaktan Eğitim, Web Teknolojileri, Öğrenme Yönetim Sistemleri, Algoritmalar.

INTRODUCTION

The history of teaching at a distance dates back almost 170 years ago. The fundamental electronics revolutions were emerged in the 1980s by developing the telecommunications industry (Keegan, 1996). The wondrous array of electronic communication technology was brought out in the 1990s, and virtual or electronics classrooms have been started to use for numerous purposes. Any distance education platform using either internet or satellite can link the people at hundreds or thousands of kilometers away. Today, it is unlikely to consider an independent distance education model from technology (Garrison, 1985).

Distance education is as an academic discipline that is a new form of the learning process lifting the necessity of being physically together of educators and learners (Moore, 2013). In conventional provision, the teaching activities are made in a school, colleges, and universities today. The basic structures of this provision have relied on lectures, seminars, laboratory practices, libraries, trips, etc. According to our point of view in this study, the journey of distance training covers the transformation of all the activities practiced in the conventional provision into a new online form. In this scope, a set of serious technology-based developments have been experienced in this field, up to now (Sevindik et al., 2010). The journey of distance education, which started with communication tools such as letters, radio, and television, continues to evolve based on the use of web-based technologies such as social media (Genç, 2010), content management (CMS) and learning management systems (LMS), depending on the developments in technology today (Demirli and Kütük, 2010). LMS is one of the most important components of e-Learning platforms as well as distance education. There are quite rich technologies under any LMS that is used conventionally. In addition, the general approach is based on a model representing various interfaces which are developed using dynamic programming languages that ensure a connection between a database management system (*DBMS*) and user interfaces.

Nowadays, with the help of the advances in technology, pattern recognition, and machine learning algorithms, several alternative approaches have been embedded into LMSs for analyzing the behaviors of the users (Jovanovic et al., 2012) (both students and teachers) intuitively, producing recommendations automatically (Varank et al., 2014), evaluating processes (Kotsiantis, 2012), and performance prediction (Livieris et al., 2012). Several algorithms such as C45, K-Means, Support Vector Machine (SVM), k-Nearest Neighbors (*k*-NN), Naïve Bayes, Apriori, Text Mining algorithm have been evaluated in terms of web based distance education (Sevindik and Cömert, 2010). A decision support system has been proposed for predicting students' grades (Kotsiantis, 2012). A multi-level classification model has been developed in order to predict academic performance of the students (Pandey and Taruna, 2014). The number of case studies can be increased. However, it is clear that using the new algorithms has been more popular than the methods used traditionally.

In this study, we execute an overview of distance education technologies, especially on LMSs. The major task of the study is the reviewing of technologies used in LMSs. In addition, it is aimed to overview the new trends algorithms in this field. The number of case studies can be increased. However, it is clear that the heuristic approaches have become more popular rather than the methods used traditionally.

The rest of paper organized as follows: the description of LMSs and important notes are presented in Section 2. The notable technologies used in LMSs are summarized in Section 3. The new trends in LMSs are outlined in Section 4. Finally, results and conclusion remarks are given in Section 5.

LEARNING MANAGEMENT SYSTEMS

It can be understood from the name of LMS that it is an online management tool which ensures comprehensive and systematic integration of training activities on the web platform. LMSs have emerged as a result of the adaptation of CMSs to training. Generally, LMSs provide a relational database that covers links curriculum, instructional resources, assessment strategies, student data, and staff proficiencies for educators. LMSs are integrated systems that enable the management of educational contents, the monitoring of learners and teachers, and the individualization of learning-teaching processes (Cömert, 2012). Also, the forums, social networking, personalization, authorization, groups, blogs, calendar and process monitoring, video conferencing support, galleries, calendar and process monitoring, blogging, simultaneous chat, online notepad, announcement/workshops, member monitoring and exam management are the communication and interaction tools of LMSs (Cömert et al., 2011).

The development processes of LMSs rely on various advanced technologies. As a popular and widely used LMS, modular object-oriented dynamic learning environment (MOODLE) has been designed using MySQL, PostgreSQL and PHP technologies (Borham-Puyal and Olmos-Migueláñez, 2011) whereas in another sample, integrated web mining and semantic learning management system (WSLMS) has been designed by using MSSQL and ASP.NET technologies (Cömert, 2012).

THE BASIC TECHNOLOGIES USED IN LEARNING MANAGEMENT SYSTEMS

When the development of web is taken into consideration and Figure 1 is examined, the process that starts with technologies such as File Transfer Protocol (FTP), email, file systems and Hypertext Markup Language (HTML) with personal computers is enriched with new technologies such as Rich Site Summary (RSS), atom, flash, java and semantics. Thus, it can be said that the web has a much more intelligent and complex structure. Figure 1 illustrates the past, present, and future of the web. In this section, we outline the notable technologies regarding the designing of LMSs. Below is a short collection of some widely used technologies in LMSs:

Document Object Model (DOM): DOM defining the logical structure of documents is an application programming interface (API) to valid HTML and well-formed Extended Markup Language (XML) documents. It ensures accessing and manipulating the desired elements in the documents (Wood et al., 2004).

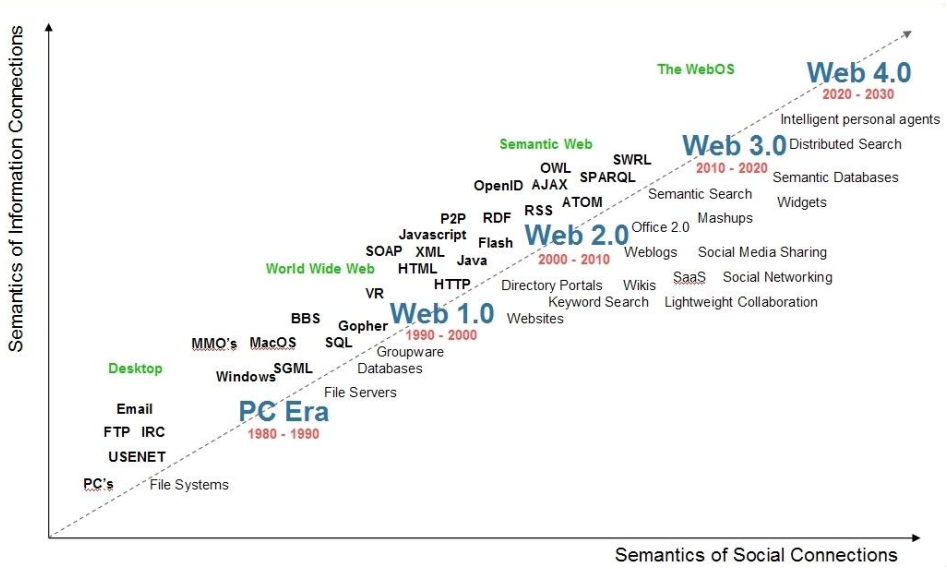
Hypertext Markup Language (HTML): HTML is expressed as a script language and only used for the marking of texts in a hierarchical scheme (Graham, 1995). The extensible version of HTML (xHTML) is used in today.

Cascading Style Sheets (CSS): CSS is a technology that enables flexible and enhanceable designs and enhances HTML coding power (Aslan, 2007).

Script Languages: Script languages are not only one of the important technology regarding the programming in client-side but also they can ensure a dynamic data fluency by combining with different technologies such as Ajax. Nowadays, several script families such as jQuery, MooTools have become popular because of the facilities they provide when designing processes (Bibeault and Kats, 2008).

Asynchronous JavaScript and XML (Ajax): Ajax is a technology that allows asynchronous data exchange between the server and the client. The biggest advantage of this technology is that it ensures only updating of the relevant field of the page without sending the whole page to the server. This situation also offers great convenience in terms of designing (Yöndem, 2009).

Figure 1. The past, present, and future of the Web (Spivack, 2007).



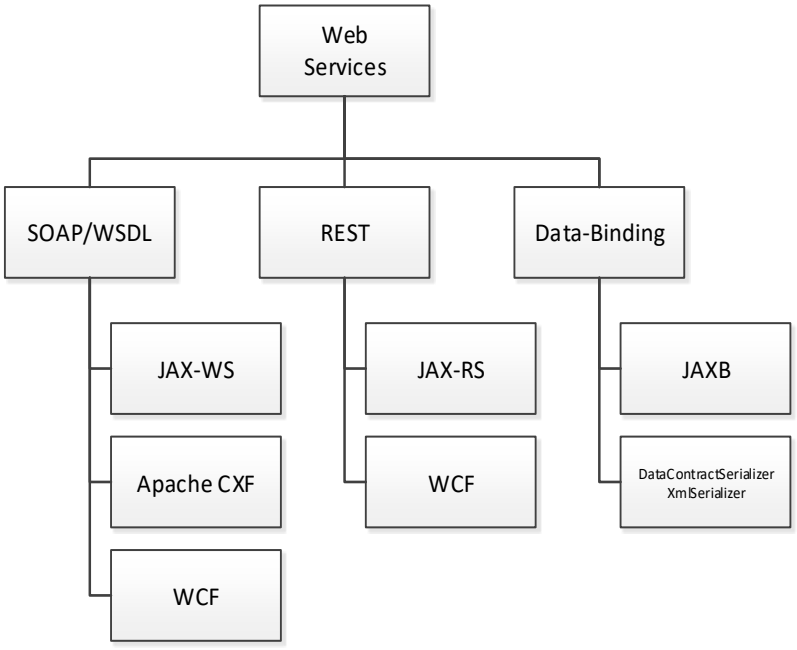
Rich Site Summary (RSS): RSS known as the standard XML format is designed to allow end users to follow easily the data stream according to user interest. Technically the working principle of RSS is based on the creating an XML file with

specified rules and reading this file by users. Hence, RSS ensures manageable data flow obtained from different domains for users (Karaman et al., 2008).

Dynamic programming languages: Dynamic programming languages such as Active Server Page (ASP) (Cohen, 2001) and Hypertext Preprocessor (PHP) (Gerken and Ratschiller, 2000) are used to make dynamic programming in the Internet world. With the help of these languages, administrative operations can be done with various number of interfaces. The maintenance and management operations of websites are facilitated.

Database Management Systems (DBMS): A database can be defined as a storage allowing for simultaneously multi-use in the broadest sense whereas DBMS is the address given to the cases where the data are arranged according to certain rules and system (Ramakrishnan and Gehrke, 2000). The most widely used DBMS approach today is the relational database. The design and management processes of DBMS are performed using the objects located in the database (Silberschatz et al., 1997).

Figure 2. The web service technologies



Web Services: The term of web service refers to the use of any software function designed to perform a specific task such as login or authorization by different systems and over HTTP (Cömert et al., 2015). In Service-Oriented Architecture (SOA), application details should be hidden and clients should never know the relationship between the service and database. For this purpose, encapsulation

method, which is a properties of object-oriented programming, should be used (Thomas et al., 2003). The web service technologies are illustrated in Figure 2.

THE NEW TRENDS IN LEARNING MANAGEMENT SYSTEMS

The numerous advanced technologies have been developed for different purposes and some of them are summarized as can be seen in Section 3. New generation Internet-based technologies try to find out heuristic approaches providing customized information from different sources. For instance, *MashUp* representing a big part of the Web 2.0 conception is a technique for creating integrated applications by using one or more different data sources that come into our lives with the new generation internet (Yu et al., 2008).

In addition, *Microformats* enable to create rich contents, which can be interpreted by computers, using existing web technologies such as *xHTML* by service developers and web publishers. *Microformats* have aimed to solve the semantically rich content creation process, which is an important issue of today's internet world, with a decentralized and standardized method. The information provided by *Microformats* may not be displayed on the browser, however, it is extremely important for search engineering (Andersen, 2007).

Recently, Artificial intelligent (AI), Machine Learning (ML) and Deep Learning (DL) have become mainstream. As it is known, AI is defined as any technique which enables computers to mimic human behavior. ML is a subset of AI and DL is a special type of ML. The differences and relationships of those fields are shown in Figure 3. The implementation of these mainstreams on LMS is not enough common, yet.

In this section, we have summarized a total of eight ML algorithms which could be used for different purposes mentioned in previous sections, in LMSs. In this scope, 5 supervised, 2 unsupervised and 1 ensemble ML algorithms have examined as described below.

Linear Regression: A linear equation form described as $y = ax + b$ constitute the basis of the linear regression. Herein, x and y show the inputs and outputs, respectively. Consequently, the main aim of linear regression is to determine the values of coefficients a and b. a expresses the intercept whereas b is the slope of the line (Preacher et al., 2006).

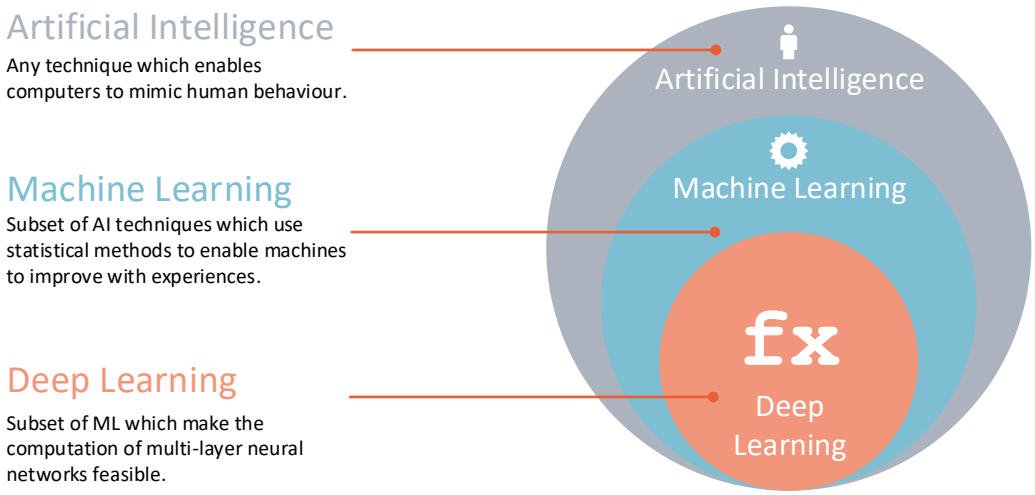
Logistic Regression: Logistic regression is a useful tool for binary classification task. This method is used a transfer function, often called as logistic function, to restrict the inputs between 0-1. The inputs are passed through this log function first, and then a threshold is applied to the output of log function for providing a binary classification (Kleinbaum and Klein, 2010).

Decision Tree: A decision tree is graph-based technique consisting of various rules produced according to studied data and it ensures every possible outcome of a decision (Safavian and Landgrebe, 1991).

Naïve Bayes: Naive Bayes is a probability-based statistical classification method. The basic principle of this method based on a hypothesis that predictors are possibly mutual and independent from the known class mark. It learns from training data by taking into consideration the conditional probability of each predictor from the known class mark. To this end, Bayes rules are used to compute the probability of the features (Ng and Jordan, 2002).

k-Nearest Neighbors (*k*-NN): *k*-NN is a supervised classifier and its basic aim is to forecast an unknown instance by using its *k*-nearest neighbors, which are stored in a training set and calculated by using different distance functions such as Euclidean (Aha et al., 1991). This algorithm may be beneficial regarding the discovering of the related contents in the system by users.

Figure 3. The new trends in LMS[1]



Apriori: As an unsupervised ML technique, Apriori is employed in a transactional database to determine frequent itemsets and to turn out association rules. This algorithm can be used to discovery hidden behaviors of the users in LMSs. This algorithm may be beneficial regarding the discovering of the related contents in the system by users (Karabatak, 2008).

Principal Component Analysis (PCA): PCA is used for destroying the dependency structure as well as dimension reduction purposes. It is a multivariate statistical method that provides recognition, classification, and interpretation. This method tries to find the most powerful pattern in the given set. Therefore, it can also be used as a pattern finding technique (Abdi and Williams, 2010).

Adaptive Boosting (AdaBoost): Bagging is a parallel ensemble since each model is designed independently whereas boosting is a sequential ensemble where each model is designed based on correcting the misclassifications of the previous model.

[1] https://rapidminer.com/artificial-intelligence-machine-learning-deep-learning/

In this scope, AdaBoost can be evaluated as a typical ensemble learning algorithm (Schwenk and Bengio, 1998).

RESULTS

To recap, in this study, after the presenting the literature review, we emphasized the importance of LMS in distance education, first. Then, a study was conducted on the traditionally used technologies for an LMS designing. In the next section, the new trends in LMS designing were outlined.

As mentioned in the study, the new trend algorithms try to provide a heuristic approach for various purposes such as predicting students' grades, producing recommendations automatically, forecasting academic performance, or discovering users' behaviors from the system log files, etc. In the context of the new trends algorithms, it was observed that three different terms have been confused with each other. For this reason, the boundary of AI, ML and DL were summarized. In this scope, a total of eight algorithms listed at below were examined:

- 5 supervised machine learning algorithms: Linear regression, logistic regression, *k*-nearest neighbours, decision tree, and Naïve Bayes,
- 2 unsupervised machine learning algorithms: Apriori and principal component analysis,
- 1 ensemble algorithm: Adaptive Boosting.

Consequently, we think that using the new trend algorithms in LMSs will ensure a high-level interactivity between users and systems as well as the more effective management systems. In addition, the hidden information such as person-specific user habits can be turned out using the mentioned intuitive algorithms.

REFERENCES

Abdi H. and Williams LJ. (2010). Principal Component Analysis. *Wiley İnterdisciplinary Reviews: Computational Statistics*, Wiley Online Library 2(4), 433–459.

Aha DW., Kibler D. and Albert MK. (1991) Instance-Based Learning Algorithms. *Machine Learning* 6(1), 37–66.

Andersen P. (2007). *What is Web 2.0?: İdeas, Technologies And İmplications For Education*. JISC Bristol.

Aslan B. (2007). Web 2.0, Teknikleri Ve Uygulamaları. In: *XII. Türkiye'de Internet Konferansı*.

Bibeault B. and Kats Y. (2008). *jQuery in Action*. Dreamtech Press.

Borham-Puyal M. and Olmos-Migueláñez S. (2011). Improving the use of Feedback İn An Online Teaching-Learning Environment: An Experience Supported By Moodle. *US-China Foreign Language* 9(6), 371–382.

Cohen MA. (2001). Automated Web Site Creation Using Template Driven Generation Of Active Server Page Applications. Google Patents.

Cömert Z. (2012). Web Madenciliği Entegre Edilmiş Semantik Web Tabanlı Öğrenme Ortamlarının Öğrenci Akademik Başarı Ve Tutumlarına Etkisi. *Fırat Üniversitesi*.

Cömert Z., Sevindik T. and Genç Z. (2011). The Use Of Google Chart for Visual Presentation of Data In Semantic Web Based Learning Management System. In: *5th International Computer & Instructional Technologies Symposium*, pp. 902–908.

Cömert Z., Kocamaz AF. and Çıbuk M. (2015). Web Tabanlı Hibrit Bir Uygulama Modeliyle Personel Bilgi Sistemi Tasarımı. In: *Akademik Bilişim*, Eskişehir: Türkiye.

Demirli C. and Kütük ÖF. (2010). Anlamsal Web (Web 3.0) ve Ontolojilerine Genel Bir Bakış. *İstanbul Ticaret Üniversitesi Fen Bilimleri Dergisi*, 18(9).

Garrison D. R. (1985). Three Generations Of Technological Innovations In Distance Education. *Distance education*, Taylor & Francis 6(2), 235–241.

Genç Z. (2010). Web 2.0 Yeniliklerinin Eğitimde Kullanımı: Bir Facebook Eğitim Uygulama Örneği. In: *Akademik Bilişim*, pp. 237–242.

Gerken T. and Ratschiller T. (2000) *Web Application Development with PHP*. New Riders Publishing.

Graham I. S. (1995). *The HTML Sourcebook*. New York: John Wiley & Sons, Inc.

Jovanovic M., Vukicevic M., Milovanovic M., et al. (2012). Using Data Mining On Student Behavior And Cognitive Style Data For İmproving E-Learning Systems: A Case Study. *International Journal of Computational Intelligence Systems*, Taylor & Francis 5(3), 597–610. Available from: http://dx.doi.org/10.1080/18756891.2012.696923.

Karabatak M. (2008). Özellik Seçimi, Sınıflama ve Öngörü Uygulamalarına Yönelik Birliktelik Kuralı Çıkarımı ve Yazılım Geliştirilmesi (Doktora Tezi). Elazığ: Fırat University Turkey.

Karaman S., Yıldırım S. and Kaban A. (2008). Öğrenme 2.0 yaygınlaşıyor: Web 2.0 Uygulamalarının Eğitimde Kullanımına İlişkin Araştırmalar Ve Sonuçları. In: *XIII. Türkiye'de İnternet Konferansı*, p. 35.

Keegan D. (1996). *Foundations of Distance Education*. Psychology Press.

Kleinbaum D. G. and Klein M. (2010). Analysis of Matched Data Using Logistic Regression. In: *Logistic Regression*, Springer, pp. 389–428.

Kotsiantis S. B. (2012). Use of Machine Learning Techniques For Educational Proposes: A Decision Support System For Forecasting Students' Grades.

Artificial Intelligence Review 37(4), 331–344. Available from: https://doi.org/10.1007/s10462-011-9234-x.

Livieris I. E., Drakopoulou K. and Pintelas P. (2012). Predicting Students' Performance Using Artificial Neural Networks. In: *8th PanHellenic Conference with International Participation Information and Communication Technologies in Education*, pp. 321–328.

Moore M. G. (2013). *Handbook of Distance Education*. New York: Routledge.

Ng A. Y. and Jordan M. I. (2002). On Discriminative vs. Generative classifiers: A Comparison Of Logistic Regression And Naive Bayes. In: *Advances İn Neural İnformation Processing Systems*, pp. 841–848.

Pandey M. and Taruna S. (2014). A Multi-level Classification Model Pertaining to The Student's Academic Performance Prediction. *International Journal of Advances in Engineering & Technology*, IAET Publishing Company 7(4), 1329.

Preacher K. J., Curran P. J. and Bauer D. J. (2006). Computational Tools For Probing İnteractions İn Multiple Linear Regression, Multilevel Modeling, And Latent Curve Analysis. *Journal of Educational And Behavioral Statistics*, Sage Publications Sage CA: Los Angeles, CA 31(4), 437–448.

Ramakrishnan R. and Gehrke J. (2000). *Database Management Systems*. McGraw Hill.

Safavian S. R. and Landgrebe D. (1991). A survey of decision tree classifier methodology. *IEEE Transactions On Systems, Man, And Cybernetics*, IEEE 21(3), 660–674.

Schwenk H. and Bengio Y. (1998). Training Methods For Adaptive Boosting Of Neural Networks. In: *Advances in neural information processing systems*, pp. 647–653.

Sevindik T. and Cömert Z. (2010). Using Algorithms For Evaluation İn Web Based Distance Education. In: *Procedia - Social and Behavioral Sciences*, pp. 1777–1780.

Sevindik T., Demirkeser N. and Cömert Z. (2010). Virtual Education Environments And Web Mining. In: *Procedia - Social and Behavioral Sciences*, pp. 5120–5124.

Silberschatz A, Korth HF, Sudarshan S, et al. (1997) *Database System Concepts*. New York: McGraw-Hill.

Spivack N. (2007). How the WebOS Evolves? *Nova Spivack*. Available from: http://www.novaspivack.com/technology/how-the-webos-evolves.

Thomas J. P., Thomas M. and Ghinea G. (2003). Modeling of Web Services Flow.

ın: *E-Commerce, 2003. CEC 2003. IEEE International Conference on*, pp. 391–398.

Varank I., Erkoç, M. F., Büyükimdat M. K, et al. (2014). Effectiveness of An Online Automated Evaluation And Feedback System In An İntroductory Computer Literacy Course. *Eurasia Journal of Mathematics, Science and Technology Education*, Eurasian Society of Educational Research 10(5), 395–404.

Wood L., Nicol G., Robie J., et al. (2004). *Document Object Model (DOM) Level 3 Core Specification*. W3C Recommendation.

Yöndem D. (2009). *ASP. net 3.5 AJAX*. İstanbul: Pusula Yayıncılık.

Yu J., Benatallah B., Casati F., et al. (2008). Understanding Mashup Development. *IEEE Internet Computing*, 12(5), 44–52.