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# EVALUATION OF EDUCATIONAL WEBSITES BY USING FUZZY LOGIC

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# ABSTRACT

This study evaluates the designs of free educational websites containing lectures, educational content, and secondary and high school materials that mostly gained attention during the COVID-19 period. Educational website design is a parameter that increases site quality and has been proven to affect learning positively. In addition, fuzzy SWARA and fuzzy WASPAS, two of the methods brought to the literature by combining fuzzy logic and MCDM, which allows evaluation according to more than one criterion, are used in an integrated manner to eliminate uncertainties in decision making. The importance weights of the educational website design evaluation criteria are determined with the fuzzy SWARA method. The design of educational websites is evaluated according to the criteria determined by the fuzzy WASPAS method. These two aspects have not been used as an integrated educational website design evaluation method before. Six education experts evaluated eight educational websites according to visual aspects, navigation, organization, interactivity, accessibility, and content. The findings of this study reveal that some website design criteria are of greater importance for educational website design.



**Keywords:** Educational website design, Website design criteria, Fuzzy SWARA, Fuzzy WASPAS

# ÖZET

Bu çalışmada ortaokul ve lise düzeyinde konu anlatımı, eğitsel içerik ve materyaller barındıran, COVID-19 döneminde diğer eğitel sitelere daha çok tıklanan, ücretsiz eğitsel web sitelerinin tasarımları değerlendirilmiştir. Eğitsel web sitesi tasarımı, site kalitesini artıran ve öğrenmeye olumlu etkisi olan bir parametredir. Ayrıca karar vermedeki belirsizlikleri ortadan kaldırmak için fuzy logic ve birden fazla kritere göre değerlendirme yapılmasını sağlayan MCDM'in birleştirilerek literatüre kazandırılan yöntemlerinden ikisi olan Fuzzy SWARA ve Fuzzy WASPAS bütünleşik olarak kullanılmıştır. Fuzzy SWARA yöntemi ile eğitsel web site tasarımı değerlendirme kriterlerinin önem ağırlıkları belirlenmiştir. Fuzzy WASPAS yöntemi ile belirlenen kriterlere göre eğitsel weib sitelerinin tasarımı değerlendirilmiştir. Bu iki yöntem, daha önce eğitsel web sitesi tasarımı değerlendirme yöntemi olarak kullanılmamıştır. Belirlenen sekiz eğitsel web sitesi altı uzman tarafından görsel öğeler, sayfada gezinme, sayfa organizasyonu, kullanıcı etkileşimi, erişilebilirlik ve içerik kriterlerine göre değerlendirilmiştir. Bu çalışmanın bulguları, bazı web sitesi tasarım kriterlerinin eğitsel web sitesi tasarımı için daha büyük önem taşıdığını ortaya koymaktadır.

**Anahtar Kelimeler:** Eğitisel web sitesi tasarımı, Web sitesi tasarım kriterleri, Fuzzy SWARA, Fuzzy WASPAS

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E1 - E6: The experts who evaluate the educational websites

W1 - W8: The educational websites being evaluated

C1 - C6: The evaluation criteria

# 1. INTRODUCTION

During the COVID-19 epidemic period, the education sector has been affected along with fields such as logistics and transportation, economy, production, tourism in the world. In order to protect public health and slow down the epidemic, cafes, restaurants, entertainment, and shopping centers, which are communal areas, were closed, and most workplaces have adopted the remote working model. Methods such as closing schools, suspending education, or continuing education with emergency remote education (ERE) have been applied according to the rates of the impact of the countries from the epidemic (Bozkurt, 2020). UNICEF (2021) announced that approximately 168 million students worldwide are affected by these closures. In addition, most of the students stated that there were disruptions in their education due to various reasons. UNICEF has published action plans and supporting reports for the continuation of education and has sought to draw attention to inequalities in education. In order to protect the right to education, UNESCO brought together more than 175 members, including Turkey, and launched the Global Education Coalition, a platform for cooperation and exchange. This platform was established to reduce the impact of schools closing and address learning losses, primarily to support disadvantaged communities and countries (UNESCO, 2021a).

For the continuity of education in Turkey, lessons were held on EBA TV and the EBA portal (MEB, 2020). Through the EBA platform, live lessons were held using Zoom, Google Meet, and Skype. MEB (2020) reported 8 GB of support to students by internet service providers as a positive development and prepared resources for teachers to improve their digital skills. Despite the measures taken, there were still disruptions in education. Economic reasons, hardware, infrastructure, and

internet deficiencies, limited methods used during teaching, difficulties in connecting to synchronous courses, lack of digital skills, resource and practice deficiencies, especially for students preparing for YKS and LGS exams, are among the causes of disruptions in education (Bozkurt,2020; Fiş Erümit, 2021). In addition to the education life of the students, their social life, psychology, learning activities together, physical activities, and eating habits were negatively affected (Çiçek et al., 2020). The problems experienced in the distance education process and the problems experienced in face-to-face education have brought the hybrid learning model to the agenda. In the hybrid learning model application, students went to school two days a week and received distance education in one day. However, due to the increasing number of cases, distance education was started again on 17 November 2020 (Yaman, 2021: 3301).

There are various paid or free applications and educational content sites for students to cover their deficiencies in the lessons. Today, educational websites are generally free sites that students sometimes reach individually and sometimes use with teachers' advice to get information about a subject and improve learning. These websites contain a variety of materials, lectures, and exercises to reinforce learning. The design of educational websites is among the factors affecting learning. It is essential because it is easy to use, simple and functional, content quality, suitable for the relevant age group, and aims to teach design (NG, 2013).

This study evaluated the designs of free educational websites containing lectures, educational content, and materials at the secondary and high school level and most visited on other educational sites during the COVID-19 period. Educational website design is a parameter that increases site quality and positively affects learning

(Nilashi & Janahmadi, 2012). In addition, Fuzzy SWARA and Fuzzy WASPAS, two of the methods brought to the literature by combining fuzzy logic and MCDM, which allows evaluation according to more than one criterion, were used to eliminate uncertainties in decision making. The introduction discusses the purpose of the research, problem statement, research limitations, definitions, fuzzy logic, and MCDM. The literature review section explains education, educational websites, design criteria, and selection process, and literature review of educational websites in the world's pandemic process and Turkey. In the methodology section, Fuzzy SWARA and Fuzzy WASPAS methods are mentioned. The data were evaluated with the methods determined in the application section.

### 1.1.Problem Statement

The COVID-19 infectious disease has brought everyday human life to a halt globally and has changed private and public institutions' functioning. Every country has taken its actions to reduce the risk of contamination. Due to martial law and limitations, people have not been able to go to their works, and students have not been able to go to their schools. In most public institutions and workplaces, technological infrastructure and methods such as working from home, flexible, and rotational work have been adopted if the job is suitable for remote work (Bozkurt, 2020: 114). Since universities have a high risk of contamination, they have shifted to emergency distance education (Bozkurt, 2020: 116). Online distance education courses have been conducted in developed countries with technological infrastructure for high schools, secondary and primary schools. Since some countries do not have the required infrastructure to conduct online education, education has been processed via television, traditional radio, paper-based learning (Bozkurt et al., 2020).

Due to the diversity in developmental and infrastructural levels of different Turkey regions, synchronized and asynchronized online courses and EBA TV provide distance education. Online classes, which are unusual circumstances for educators and learners, have often led to some problems. Problems such as access to the Internet, the lack of technological devices of the students such as computers, phones, or tablets to attend the courses, and the limited network access for students who attend courses by phone in some regions have been struggling for all students, parents, and educators. Besides, since our country's education system is based on face-to-face education, students have had difficulties adapting to online education. There have been problems in focusing on the lesson. There has been no established education plan for online tutoring at home, and there has been no authoritarian figure of a teacher, such as in face-to-face teaching. These reasons are factors that negatively affect the academic success of students (Bozkurt, 2020).

Students who have not been able to get sufficient education in online courses due to various reasons have tried to make up for their deficiencies by using various educational websites. The compliance of these educational websites with the design principles, which are at the basis of criteria that are essential for a website, such as the age group of the target audience, the content they provide, the purposes of preparation, and ease of use, dramatically affects the quality of the education provided (Nilashi & Janahmadi, 2012).

The design criteria weights of educational websites deviate from the design criteria weights of other websites (Cebi, 2013). Just as an e-commerce site has design criteria provided to sell products and exhibit the product to the user, educational websites also have various educational website design criteria to prioritize only the

information presented, keep the student's interest2 in the subject, and support the subject. These design criteria should be considered in order for educational websites to be successful. Due to the variety of web tools, it is more manageable to develop a website today than in the past. Nevertheless, as well as developing a website, developing a website to fit the design criteria depends on the experience and knowledge of the web developer or developers who prepare the site.

For this reason, educational websites differ from each other in terms of design quality. An excellent educational website designed for its purpose and target audience is an important criterion that affects education quality (Nilashi ve Janahmadi, 2012). Evaluating educational websites ' designs has become even more critical with the increase in educational websites' benefits during the pandemic.

The fuzzy SWARA method, which is generally used to determine criteria weights when determining the weights of the criteria for educational website designs, introduced to the literature in 2010, is easy to apply and eliminates the uncertainties in decision-making. The fuzzy WASPAS method is used to evaluate educational websites' design, frequently employed in alternative selection. These two evaluation methods together have not been utilized to evaluate the design of educational websites in the literature before.

### 1.2.The Aim of the Study

It is among the study's objectives to determine the design criteria of educational websites and the importance weights of the criteria and present them for future studies, web designers, and educational technologists to use in their studies. This thesis aims to evaluate educational websites by using Fuzzy SWARA and Fuzzy

WASPAS methods in an integrated way and observe whether there is a relationship between them by comparing click-through rates and website rankings.

### 1.3.Research Questions

In this thesis, mostly visited educational websites throughout the pandemic period will be evaluated concerning their designs considering educational website design criteria by obtaining the criterion weights and importance order by the opinions of a group of experts for educational websites' design criteria. Educational websites are of great importance because of their widespread usage during the pandemic, for which the website design affects the learning process.

In this context, answers to the following questions are investigated:

- What are the weight points and the importance orders of the educational website design criteria?
- What criteria may/should be ignored in the design of educational websites used during the pandemic period?
- Is there a relationship between the educational website's compliance with the design criteria and the rate of visits?
- Which criteria have been used more effectively in educational website designs?
- Is there a relationship between the educational website design evaluation ranking and the click-through rates of the sites?

### 1.4.Research Limitations

Educational websites that are free and do not require user login were used in the research. Since we are in the pandemic period, the experts were interviewed online, and the evaluation files were collected online. A maximum of 3 months (Alexa) data were obtained for the site traffic information of educational websites. The Fuzzy WASPAS and SWARA computer programs were developed, and the analyzes were made using Microsoft Excel.

### 1.5.Definitions

Educational website: Web-based educational resources that offer various educational materials and content to enhance and support learning.

### 1.6. Fuzzy Logic

In daily life, no exact data consists of 0 and 1 as in the computer. In this environment of uncertainty, people can make fuzzy inferences or make decisions by using their own experiences and observations in decision-making and thanks to the approximate thinking characteristic of human beings (Karakaşoğlu, 2008). Information sources used in fuzzy situations include uncertainty and complexity in different ways (Şen, 2004: 7 cited by Karakaşoğlu, 2008: 55). In these uncertainties, people use fuzzy verbal terms instead of precise and clear expressions when deciding in the face of a situation. Examples of these terms are many verbal terms such as hot, cold, warm, cloudy, partly cloudy, sunny, a lot, a little, exceptionally, some, very intense. Increasing or decreasing the brightness of the computer while working is an example of how the human brain behaves in blurry situations (Altaş, 1999).

Computers cannot think like humans and need precise and clear data to act and make decisions. In this context, the thinking and decision-making mechanism that enables computers to make consistent and correct decisions with complete and imprecise information is called fuzzy logic (Allahverdi, 2002: 157). Lotfi Zadeh first mentioned fuzzy logic in his article named "Fuzzy Sets," published in 1965. In the article, fuzzy logic and fuzzy set theory define their basic operations, properties, and fuzzy relations. Fuzzy logic started to be used in the second half of the 1970s. Zadeh's two articles written in 1973 and 1975 were more influential than his article in 1965 (Altaş, 1999: 81). In these two articles, Zadeh talked about the use of fuzzy logic in systems with uncertainty, approximate reasoning, fuzzy rules, the use of linguistic variables instead of or in addition to numerical variables, the expression of relations between variables with fuzzy logic, fuzzy sets, and fuzzy operators (Zadeh L., 1975; Zadeh L., 1973). In 1975, for the first time, fuzzy logic was integrated into the control system of the steam engine and applied by Mamdani et al. After the second half of the 1980s, it gained momentum with the use of fuzzy logic in the products of the Japanese, and it continues to be used today (Altaş, 1999: 81).

Fuzzy logic is used to mathematically model the behavior within the imprecise limits specified by verbal expressions, which can also be defined as a decision-making mechanism by the expert person or persons. Since there are uncertain fuzzy sets in modeling, they are expressed as fuzzy. Fuzzy logic gives meaningful results when the expert cannot express it with certain lines, but its approximate regional boundaries are certain (Şahin, 2017: 17).

### 1.6.1. Fuzzy Sets

Fuzzy sets are one of the essential concepts of fuzzy logic, which emerges due to the inability to express fuzzy situations arising from uncertainty in real life with classical set logic. Zadeh (1965) stated that fuzzy sets are an object class with a membership degree and a continuity of membership degree. "The set of real numbers greater than 1", "the set of beautiful women," "the set of tall men" do not form sets in a mathematical sense. However, such vaguely defined clusters are essential in human thought, abstraction, and pattern formation (Zadeh, 1965: 338). Fuzzy sets are expressed as mathematical models for transferring verbal expressions used in decision-making to the computer (Şengün & Tektaş, 2020).

In classical set logic, an element takes the value 1 if included in a set and 0 if it is not. There is no such thing as an indefinite element in classical set logic. An element is either included in the set or not. In classical set theory, an element may belong to more than one set, but its membership degree is always 1. On the other hand, Fuzzy set theory provides powerful tools to measure real-life uncertainties and provides a meaningful expression of uncertain concepts in natural language. In fuzzy set theory, there is partial membership of an element to a set. Those that are fully included in the set are assigned values between 1, those not included in the set 0, and the elements that are uncertain whether they are included are assigned values between 0 and 1. This value indicates the degree of belonging of the element to the set, and this degree adds uncertainty to the boundaries of the fuzzy set (Altaş, 1999; Klir & Yuan, 1995). Figure 1 is shown as an example of comparing classical and fuzzy sets. In the classical cluster representation, people with a height of 175 cm and above are considered tall. In the fuzzy set graph, the membership value of the elements included

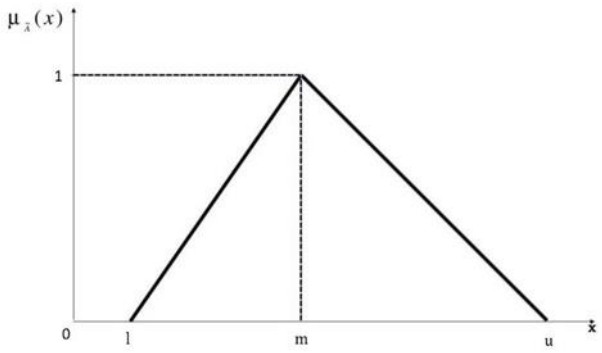
in the length set is indicated by verbal expressions such as "somewhat short, little long, too long, too long" in daily life (Lee et al., 2013).

### 1.6.2. Triangular Fuzzy Number (TFN)

Due to its conceptual and computational simplicity, fuzzy triangular numbers are a type of fuzzy number frequently used in practical applications (Yeh & Deng, 2004; Awasthi et al., 2011). The triangular fuzzy number is expressed as (l, m, u) as seen in Figure 1. “l” value is defined as the lower limit, the “m” value as peak, and the “u” value as the upper limit. The membership function $\mu_{\tilde{A}}(x)$ is expressed as given below (Hsieh et al., 2004: 575).

$$\mu_{\tilde{A}}(x) = \begin{cases} (x-l)/(m-l), & l \le x \le m, \\ (u-x)/(u-m), & m \le x \le u, \\ 0, & otherwise \end{cases}$$

*Figure 1.6.1 The membership function of the triangular fuzzy number.*




## 1.7. Multiple Criteria Decision Making (MCDM)

Multi-criteria decision-making (MCDM) was introduced as an essential field of study in the early 1970s. The number of contributions to theories and models that can be used for multi-criteria systematic and rational decision making has continued to increase (Carlsson & Fullér, 1996). Although it is not known when the official

study of decision-making began, the first known recorded work on MCDM was by Benjamin Franklin. It may be the first time he established a link between rational decision-making and human preferences (Köksalan et al., 2013).

MCDM is a decision maker's selection process from multiple alternatives, often with conflicting criteria. Suppose a decision will be made according to a single criterion. In that case, it is appropriate to use classical decision analysis techniques, while multi-criteria decision-making methods should be used for decision problems involving more than one simultaneous decision (Ulucan, 2004: 306; cited in Karakaşoğlu, 2008). The steps followed in the MCDM method are as follows:

- Criteria and alternatives related to the subject are determined.
- The relative importance of the criteria is determined.
- Each alternative is evaluated based on all criteria, and the alternatives are listed (Ballı, 2005: 12; cited in Karakaşoğlu, 2008).

MCDM is a general term for all methods used in the decision-making process according to people's preferences, in cases where there are more than one criteria that are often in conflict with each other (Mardani, 2015: 517). MCDM methods are designed to identify alternatives, categorize alternatives in a few categories, or put alternatives in subjective order of preference. Many MCDM methods have been developed to date, and it has become challenging to determine which method to use in the decision-making phase of the study. Some of the MCDM methods introduced to the literature are as follows: TOPSIS, VIKOR, AHP, ARAS, ELECTRE, DEMATEL, COPRAS, MOORA, SWARA, PROMETHEE, WASPAS. The following steps should be followed when determining the best decision-making method according to the situation.

- Creating the decision problem
- Ranking of priorities
- Collection of alternative assessments
- Making suggestions (Karakaşoğlu, 2008: 18)

Multi-criteria decision making is divided into two main areas as multi-objective decision making and multi-quality decision making. The main difference between them is; multi-attribute decision making concentrates on discrete decision spaces, multi-objective decision making concentrates on continuous decision-making. In multi-criteria decision analysis, the options are finite and discrete, and the options are handled one by one and sorted and evaluated according to many criteria. In multi-objective decision making, it can be applied to deterministic problems with a large number of suitable options, and the set of options is formed with the constraints defined on the decision variables, more than one objective function is handled at the same time (Çiftli, 2006: 49-50).

# 2. LITERATURE REVIEW

## 2.1.Education in the World During COVID-19 Pandemics

In December 2019, a severe acute respiratory syndrome coronavirus 2 infection occurred in Wuhan, Hubei Province. On February 12, 2020, the World Health Organization officially named the disease caused by the novel coronavirus as coronavirus disease 2019 (COVID-19) (Zu et al., 2019: 1). COVID-19, which spread rapidly around the world and caused the death of many people, pushed countries to take measures such as quarantine, curfew, and travel restrictions. Bruin et al. (2020) gathered the measures taken in their studies under the following headings; mobility restrictions, socio-economic restrictions, physical distancing, hygiene measures, communication, international support mechanisms.

Covid-19 has negatively affected health, economy, tourism, agriculture, logistics and transportation, education, and many other areas. One of the most important of these areas is education. Emergency Remote Education (ERE) applications were started worldwide by showing a quick reflex by many educational institutions to compensate for the disrupted education due to the pandemic (Bozkurt, 2020: 116). Education practices during the Covid-19 crisis are defined as emergency distance education (Bozkurt et al., 2020; Hodges et al., 2020). In an emergency, distance education, unlike distance education, emerges in mandatory situations, produces temporary solutions for needs, and is an effort to keep education alive with the opportunities available at the time of crisis (Bozkurt et al., 2020; Bozkurt, 2020). Some of the various online education tools/platforms to ensure education continuity in the pandemic are: Google Classroom/Open Online education, Udemy, GoToMeeting, Coursera, memory.com, Peer 2 Peer University, openculture.com, Youtube, Skype,

Edx, Blackboard, Easyclass, MOOC.org, alison.com, Khanacademy.org, TED-Ed, Codeacademy.com, Stanford Online, futurelearn.com, vedamo.com, rcampus.com, learnopia.com, Teachers pay Teachers, Thinkific, academicearth.org, iTunesU Free courses, lessonpaths.com, memrise.com, funbrain.com, whyville.net, Edmodo, Schoology, google hangouts, Zoom, ClassDojo, Whatsapp (Onyema et al., 2020).

In order to prevent the spread of the epidemic, educational institutions, universities, and schools were closed for specific periods depending on the countries, and an emergency distance education model was made. UNESCO's (2020) data presents the number of countries closed as of February 17, 2020, the number of students whose education life was affected, and the number of days when schools are closed. In the light of these data, 167 countries closed and reached the highest number on March 30, 2020. 1 billion 450 million learners (82.8% of total enrolled learners) were affected by this closure. UNICEF (2021) shows with the table below that from March 11, 2020, to February 2021, schools in 14 countries were closed for about one year, and more than 168 million students were affected.

*Table 2.1.1 Number of countries/children where schools have remained closed since March 2020 (UNICEF,2021)*

| Region | Schools have remained closed almost an entire year (# of countries) | School children affected Number (in millions) | School children affected Per centage |
|---|---|---|---|
| **East Asia & the Pacific** | 1 | 25 | 15% |
| **Middle East & North Africa** | 3 | 9 | 5% |
| **East & Southern Africa** | 0 | n.a. | n.a. |
| **Western & Central Africa** | 0 | n.a. | n.a. |
| **Europe & Central Asia** | 0 | n.a. | n.a. |

| | | | |
|---|---|---|---|
| **Latin America & the Caribbean** | 9 | 98 | 58% |
| **South Asia** | 1 | 37 | 22% |
| **TOTAL** | **14** | **168** | **100%** |

With the closure of schools, countries tried to ensure continuity in education by switching to urgent distance education. However, the technological infrastructure inadequacies that change according to the development level of the countries and the global economy, which was negatively affected by the pandemic, increased inequality in education. Onyema et al. (2020) surveyed 200 participants, consisting of teachers, students, and parents selected from different countries, in their study investigating the impact of Covid-19 on education. The research uncovered that more than 70% of the participants did not have a computer and had insufficient access to the internet. Their study's factor analysis found that school policies, network issues, poor digital skills, lack of training, poor electricity, lack of funding, and inadequate facilities are the most significant barriers to accessing online education during the pandemic period.

The OECD (2020) report emphasized that families and teachers should be supported during the pandemic period. Some families and teachers mentioned the necessary regulations governments could make on poor digital skills, lack of curriculum and instruction, and lack of time. Providing resources to improve information and communication technologies (ICT) to families and teachers, addressing curriculum and infrastructure deficiencies, childcare support, and paid leave policies for working families, strengthening the school-parent relationship for better guidance and parents on how to guide their children. Suggestions have been made, such as informing teachers and supporting teachers in effectively incorporating

online tools into teaching practices (OECD, 2020). Also, students must be guided and motivated to active learning to ensure that online tools are suitable for students' competencies and digital literacy, and supported to develop positive learning attitudes, self-efficacy, and self-learning abilities to ensure that they follow the curriculum (OECD, 2020; OECD, 2019).

UNESCO has presented the Education Finance Watch (EFW) report, which investigates countries' education budgets before and after COVID-19. To understand the short-term impact of the pandemic, it validated the data of samples from 29 countries by comparing them with World Bank data. The dataset compared the pre- and post-crisis trends with data from the first budget two years before and after the COVID-19 crisis. They reported reductions in education budgets in 65 percent of low- and lower-middle-income countries and only 33 percent of high- and upper-middle-income countries after the onset of the pandemic. On average, they reported that annual education budgets were 1.1 percent before COVID, while they increased by 4 percent after COVID and showed a positive trend. However, they noted that this upward trend is more petit in low- and middle-income countries than in high- and upper-middle countries, exacerbating pre-existing inequality between countries (UNESCO, 2021b).

*Table 2.1.2 Change in education budgets before and after Covid-19 (%) (UNESCO, 2021b)*

| | **All countries** | **High- and upper-middleincome** | | **Low- and lower-middleincome** | | |
|---|---|---|---|---|---|---|
| | **Pre-Covid** | **PostCovid** | **Pre-Covid** | **PostCovid** | **Pre-Covid** | **PostCovid** |
| **Total education budget** | | | | | | |
| Change in education budget | 1.1 | 4.0 | 2.2 | 6.7 | 0.3 | 2.0 |
| Share of countries decreasing education budget | 44.8 | 51.7 | 41.7 | 33.3 | 47.1 | 64.7 |
| Average decrease in countries that decreased their budget | -8.3 | -4.6 | -6.9 | -7.4 | -9.1 | -3.6 |
| Average increase in countries that increased their budget | 8.7 | 13.2 | 8.8 | 13.8 | 8.7 | 12.4 |
| **Education's share of the total budget** | | | | | | |
| Average change in percentage points | -0.5 | 0.1 | -0.3 | -0.1 | -0.6 | 0.2 |
| Average share | 13.4 | 13.5 | 13.7 | 13.6 | 13.2 | 13.4 |

## 2.2.Education in Turkey During the Pandemic Period

The Ministry of Health announced that the first coronavirus case in Turkey was detected on March 11, 2020 (Genel Koronavirüs Tablosu, 2020); the patient and his family were isolated. In order to prioritize the health and welfare of the society and prevent the epidemic rate, primary, secondary and high school education was suspended for one week and university education for three weeks on March 16, 2020. It has been decided to continue education via television and the internet with distance education as of March 23 (Wikipedia, 2021).

In order to ensure the continuity of education, the Ministry of National Education has started to provide distance education both on the online portal and on television in cooperation with the EBA portal, EBA TV, and TRT. EBA TV's

primary, secondary and high school channels were broadcast simultaneously for 2516 hours in 10 TV studios in Ankara and Istanbul. In the broadcasts, 674 teachers from 93 different branches took part in 2358 lesson videos and 221 learning activity recordings, and 20 of the programs were special education, 20 experimental shows, 69 arts such as drama and drawing, 37 guidance, 39 'smart.' Breaks' and 36 covered exercise and hobbies (Fis Erumit, 2021). MEB made investments to strengthen the infrastructure of EBA and tried to increase the number of learning materials. In order to protect the mental health of students and parents, psychosocial guides have been prepared, information has been provided about the effects of Covid-19, and a helpline for psychosocial support has been established. Unique materials have been added to the remote EBA portal for special education students. MoNE has prepared a professional development program for teachers in cooperation with UNESCO. With the closure of schools, 17 programs on different subjects were prepared to support teachers' professional skills and presented to teachers via distance education (Özer, 2020).

In the study of Fiş Erümit (2021), the opinions of a dozen primary, secondary and high school students about the lectures on EBA TV were taken. During EBA TV broadcasts, students are at the center of both the learning process and the management. They need the support of their families in terms of educational process management and continuity. The students stated that the limited teaching methods used by the teachers in the lessons they took over EBA TV and the negative effects of these methods on their motivation, the lack of exercises to reinforce the learned subjects, the lack of resources, and the expectations of the students preparing for the LGS and YKS exams were not fully met. They experienced technical difficulties while connecting to the synchronous lessons in the first days. To use the EBA portal

and synchronized lessons, teachers encourage students to use the portal regularly, give homework and exercises on the portal, course videos, animations, books, etc., to the content on the portal. They also expressed their positive opinions, as well as being able to access them in different formats.

Students need parents' support to continue their education and to solve the technical problems they experience. Here, the level of parents in digital literacy is essential. Another problem is the lack of internet and technological equipment generally experienced by families with many children or rural areas. The Ministry of National Education announced that internet service providers' 8 GB of student support is a positive development (MEB, 2020). However, hardware deficiencies continue, and more fundamental improvements should be made in terms of infrastructure. Some of the problems experienced in the essential teaching and learning process, Bozkurt (2020) include economic dimension, trauma and anxiety, social inequality, digital division, new roles of parents, digital competence and skills, protection of digital data and ethical concerns, course design in distance education, etc. expressed and made recommendations.

During the Covid-19 period, teachers, academics and administrators, and students faced various problems. Sari and Nayır (2020) investigated the problems experienced by teachers in the distance education process with a study group consisting of 65 teachers. They stated that the first and most crucial problem is that teachers have difficulties accessing the internet and lack infrastructure, classroom management, and human resources. Other problems declared by teachers are related to the behavior of teachers and students, and the distance education process itself is among the results obtained. The findings obtained from the research were that the

participants were not ready for the distance education process, classroom management, application deficiencies, technology support, and distance education, and the participants did not have sufficient knowledge and experience for distance education. Difficulties such as limited internet access in rural areas, lack of technological equipment, internet speed, and frequent interruptions are other factors that negatively affect the distance education process of teachers. In the study, it is stated that the preparation of an action plan for global crises, the provision of technological infrastructure and equipment, the preparation of a new emergency action plan according to the teaching skills and experience of the teachers, and the work to develop and support the technological skills of the teachers.

### 2.3.Educational Websites

Today, many websites with educational content and users are among the advantages of using educational websites that save time, ease of access, and cheap costs. Educational websites are generally the first resources people refer to when they need information (Henkoğlu & Mıhcı, 2012: 28). It is a resource that helps people obtain information on the internet by changing their learning and teaching process perspectives. With the increasing access to the internet, websites have become popular educational literature (Abdullah, 1998).

Elshair (2002) defines educational websites as websites with free access to education, most designed for educational purposes, and accessible documents such as articles and books to students, researchers, and academics. He stated that educational websites aim to help users find relevant information in various fields, facilitate teaching in various content areas and different education levels, and provide digital resources and materials (Elshair, 2002).

Educational websites must attract student attention, be exciting and entertaining, and encourage further research. It has been stated that the site should be evaluated to understand whether the site has achieved its purpose, receive feedback from users, and give direction to the site in line with the feedback received (Yiğit et al., 2007). Keskinkılıç and Karataş (2011) stated in their study that educational websites should present information effectively with various materials and facilitate the user's work. They stated that the information should be presented to the user in a clear, accurate, well-designed, and most straightforward form and that this would be done with good planning (Keskinkılıç & Karataş, 2011).

### 2.4.Website Design vs. Educational Website Design

Many studies in the literature evaluate the usability, quality, interaction, content, and design of websites. With these studies, many evaluation criteria have been presented for different types of websites in different areas. In their study, Tractinsky et al. (2004) revealed that the user's interaction with the web page in the first few seconds decides whether to continue using the website (Tractinsky et al., 2004). They evaluated with 50 web pages and 40 participants selected from various fields. The first impression importance has been affirmed in many studies, revealing the importance of website design.

Garett et al. (2016) examined the design criteria of websites in their literature study, which stated that the most frequently mentioned web design criteria in the studies are navigation, graphical representation, organization, content utility, purpose, simplicity, and readability (Garett et al., 2016). In their study, basic website design criteria were analyzed to increase website usage. It was emphasized in this work that these criteria might have different criteria elements and different rankings according

to different website models. Consequently, one of the main factors affecting the design criteria is the type of website. The content presented to the user in websites prepared for various purposes, the interaction rate according to the website type, and the target user audience affect the design criteria. Cebi (2013) divided websites into four groups: commercial, information, entertainment, and communications (Cebi, 2013). His study determined the website evaluation articles, website types, and criteria published between 2006 and 2011. He then calculated the importance weights of the criteria according to the website types using the DEMATEL method. They concluded that the order of importance of the design criteria determined varies according to the websites' types. It was stated that the criteria have different degrees of importance according to the type of website and the interaction of design criteria.

Educational website design is a challenging concept as it aims to educate its users. In addition to the knowledge and field experience that the web designer holds, some characteristics are required to design more efficient educational websites. In his study, NG (2013) listed these characteristics as follows. Since the educational website design is a multidisciplinary project, the designer should know communication theory, consider human-computer interaction, and understand multimedia technology comprehensively. Simultaneously, if it is a website aimed at young learners, excellent pedagogical knowledge is required. Although website development is more straightforward with today's emerging web tools, creating an educational website, in particular, is a comparatively complex and demanding job. Educational technologists are usually involved in improving, designing, implementing, and evaluating educational technology and human learning. The education technologist profession existed in the sixties and seventies before the internet (Cuban 1986). Today, with the development of technology, he participates in designing and developing specialized

educational materials. Graduates of the CEIT department in Turkey can become Educational Technologists thanks to their technological competence and pedagogical knowledge (Telli & Selim, 2009). While preparing educational websites, the knowledge of Education Technologists can be utilized.

While designing the educational website, consideration should be given to color, multimedia tools, and typography for different age groups, considering the target audience's age group. A visually attractive and user-oriented design should be selected to spend more time on the website and achieve learning goals more effectively. Necessary instructions and directions should be presented to the user in terms of ease of use and quality.

### 2.5.Educational Web Site Determination Process

In determining the educational websites to be investigated in this thesis, particularly in the current COVID-19 pandemic period, websites with a higher current use rate have been selected. For this reason, Alexa and Semrush, the virtual assistant AI technologies that provide global web metrics, are used to determine the educational websites to be investigated. Alexa and Semrush are websites that provide web traffic measurement and SEO tools services. 3-month data was obtained using Alexa and daily visited educational website data using Semrush. The best website ranking feature by category in Alexa was removed in September 2020, stating that separating sites into large categories do not reflect the variety of websites today (Alexa, 2020). Therefore the best educational website ranking category in Turkey was not reached. Then, using two different SEM tools services (Alexa and Semrush), educational websites in the general list rankings and the most visited educational websites were obtained using the keywords education, distance education, educational

website, online education. Websites that provide free education, generally including secondary and high school levels, are considered and examined in line with the research scope. Paid educational websites, websites selling books, online courses, forums, and websites requiring user membership are eliminated. Some websites that require user login solely are investigated.

Search engines are employed to search for information on the internet. Search engines are software that enables the query to be returned to the user with a list of appropriate titles and prior information (Krrabaj et al., 2017: 1). Keywords are critical for websites to meet with their potential users. For this reason, the keyword lists of the determined websites were examined using Alexa. In the results, it was seen that phrases such as "lecture", "test", "lecture book", "answers" (“konu anlatım”, “test”, “ders kitabı”,”cevapları”) were found following the related topic or course title information. It has been observed that the usage rate of keywords such as online education, e-learning, and educational websites is shallow. Since the data obtained here is big, and only the words that occur most frequently are considered, the complete data is presented in the appendix for brevity.

*Table 2.5.1 The most repetitive words and phrases in Keywords*

| **Repetitive Phrases** | **The number of repetitions** |
|---|---|
| cevapları | 271 |
| ders kitabı | 200 |
| test | 147 |
| konuları | 134 |
| konu anlatım | 103 |

The user visit rates of the websites to be evaluated, the ranking of the websites as a result of Alexa's 3-month data (April, May, June 2021), and the click-through rates of the websites obtained by Semrush's one-month traffic rates (May 2021) Table 2.5.2 and Table 2.5.3 is given. In the light of these data, it has been seen that beforecevap.com is ahead in the global and tr rankings given by Alexa, and when the traffic rates of Semrush are considered, the website that receives the most traffic is beforecevap.com.

*Table 2.5.2 April, May, June 2021 click-through rates of educational websites obtained using Alexa*

| **Alexa - Traffic Metrics (April, May, June 2021)** | | | | |
|---|---|---|---|---|
| | **Web Site** | **Global Rank** | **Rank in Country (TR)** | **Daily Time on Site (Average Minute and Second)** |
| W1 | khanacademy.org.tr | 565.558 | 20.431 | 02:49 |
| W2 | evvelcevap.com | 61.749 | 2.779 | 08:04 |
| W3 | matematikciler.com | 179.546 | 5.932 | 01:58 |
| W4 | derscalisiyorum.com.tr | 603.934 | 26.186 | 02:24 |
| W5 | biyolojiportali.com | 262.635 | 7.273 | 03:50 |
| W6 | dersimis.com | 351.608 | 14.157 | 02:32 |
| W7 | selinhoca.com | 633.487 | 20.830 | 02:05 |
| W8 | fenbilimleri.org | 503.075 | 11.788 | 05:34 |

*Table 2.5.3 May 2021 click-through rates of educational websites obtained using Semrush*

| **SemRush - Traffic Analytics (May, 2021)** | | | | |
|---|---|---|---|---|
| | **Web Site** | **Global Organic Search Traffic** | **TR Organic Search Traffic** | **Avg. Visit Duration** |
| W1 | khanacademy.org.tr | 143.9K | 143.6K | 16:00 |
| W2 | evvelcevap.com | 3.8M | 3.8M | 15:30 |
| W3 | matematikciler.com | 390.6K | 388.8K | 11:38 |

| | | | | |
|---|---|---|---|---|
| W4 | derscalisiyorum.com.tr | 33.6K | 33.3K | 15:26 |
| W5 | biyolojiportali.com | 156.4K | 155.2K | 14:19 |
| W6 | dersimis.com | 69K | 68.1K | 11:50 |
| W7 | selinhoca.com | 54.7K | 54.3K | 09:30 |
| W8 | fenbilimleri.org | 17.3K | 17.3K | 07:55 |

### 2.6.Educational Website Evaluation Criteria

A detailed literature study was conducted to determine the educational website design criteria. Fourteen studies were examined, and the benefited studies are presented in Table 2.6.1.

*Table 2.6.1 Studies used to determine Educational Website Design Criteria*

| Yıl | Yazarlar |
|---|---|
| 2005 | Monideepa Tarafdar, Jie Zhang |
| 2007 | Ahmet Yurdadur, Özgür Çini, Mevlüt Doğan |
| 2008 | Layla Hasan, Emad Abuelrub |
| 2008 | Monideepa Tarafdar, Jie Zhang |
| 2010 | Hsiu-Fen Lin |
| 2010 | Suzan Duygu Eristi, Ozden Sahin-Izmirli, Serkan Izmirli, Mehmet Firat |
| 2010 | Gülçin Büyüközkan, Jbid Arsenyan, Gürdal Ertek |
| 2012 | Mehrbakhsh Nilashi, Nasim Janahmadi |
| 2013 | Selçuk Cebi |
| 2014 | Layla Hasan |
| 2014 | Wing-Shui Ng |
| 2015 | Renuka Nagpal, Deepti Mehrotra , Pradeep Kr. Bhatia, Arun Sharma |
| 2016 | Dimpal Jain, Rakesh Garg, Ashu Bansal, K. K. Saini |
| 2018 | Yogi Udjaja, Sasmoko, Yasinta Indrianti, Osama Agami Rashwan, Samuel Anindyo Widhoyoko |

**Visual Aspects:** One of the main principles of website design is the use of multimedia tools. Multimedia tools such as image, audio, video, animation, and text form the website's visual design. The website's quality is affected by visual and video quality, font size and layout, readability, ground-shape relationship, color scale, and harmony. Hence, the quality and use of these elements also have an important place in the visual design of educational websites as they affect the subject's comprehensibility (Cebi, 2013; Ng, 2014; Eristi et al., 2010).

**Navigation:** Easy navigation on the website is about how the content is organized. Links used to switch between pages should work properly and be visible. Headings should be used for the user to understand the page he is on and must be able to return to the pages the user has visited before. The layout of the site menu, the order and quality of the links, easy accessibility, and hyperlinks should be considered while designing the website. Being able to search for a topic within the website on educational websites or to switch between topics easily is notable for the navigability principle (Tarafdar & Zhang, 2008; Ng, 2014; Eristi et al., 2010; Lin, 2010; Hasan, 2014; Jain et al., 2016; Büyüközkan et al., 2010;).

**Organization:** Educational website designs should have a simple and understandable structure. Sitemap, navigation menu, presence of the logo on every page are necessary for the site's organization. A further understandable structure is obtained by grouping the subjects under each discipline's subtitles (Hasan, 2014; Hasan & Abuelrub, 2008; Tarafdar & Zhang, 2005).

**Interactivity:** The ability of users to interact with the website increases the quality of the site. An effective service should be provided to the user with a frequently asked

questions page, help form, and feedback (Büyüközkan et al., 2010; Nilashi & Janahmadi, 2012; Jain et al., 2016).

**Accessibility:** The easy and fast loading of a web page increases the user's time on the site. At the same time, the pages within the website must be complete and without inadequacy. It is vital that the educational materials on the site can be downloaded and accessed with minimum effort (Lin, 2010; Udjaja et al., 2018; Ng, 2014; Yurdanur et al., 2007).

**Content:** One of the fundamental components of educational websites is content. The update dates of the information transmitted to the user should be specified, activities should be found, and the lecture should be supported with videos and questions with solutions. The information of the instructor who prepared the content should be included. Headings and subheadings should be consistent and coherent in lectures (Hasan, 2014; Cebi, 2013; Nagpal et al., 2015; Yurdanur et al., 2007).

### 2.7.History of the evaluation of educational websites

With the advancement and widespread use of the internet and web design tools, various websites have been created in about every field. Websites are designed and developed in every field, such as e-commerce sites, educational websites, corporate sites, government agencies, schools sites, personal blogs, entertainment, and game sites. Websites have different web designs, animations, contents, formatting, and quality according to their subject areas, the purpose of use, and the target audience. Usually, they are evaluated for their suitability, usability, accessibility, and quality with the design rules of websites in their subject area (Tarafdar & Zhang, 2008; Nagpal et al., 2015; Abu Shawar, 2015; Büyüközkan et al., 2007). In the light

of these researches and growing technological enhancements, websites and their criteria continue to expand and evolve.

Websites have become a part of our lives and have been adopted in education, such as in every field. Besides the students' education at schools, there are many paid or free educational websites and e-learning platforms where students can research, watch educational videos, or take online training. Not only for students but with the concept of lifelong learning, people practice many e-learning websites and online and online education platforms to improve themselves and receive training in professional or interests. There are studies evaluating websites that are widely used in education in many ways and with different methods. Fuzzy multi-criteria decision-making methods have also been used in studies to evaluate educational websites. Although the first study evaluating educational websites with fuzzy logic is not known, the studies that evaluate educational websites and e-learning websites obtained from the literature study with various fuzzy MCDM methods or offer new approaches are as follows.

Hwang, Huang, and Tseng (2004) also developed EWSE (Educational Web Site Evaluator) using fuzzy theory, gray system, and group decision method in their research to evaluate educational websites. The study evaluates educational websites with EWSE using the main criteria of student interface design, quality of educational content and evaluation functions, and their sub-criteria. They stated that the EWSE could provide students and teachers looking for educational resources with precise and multidimensional information to select the desired websites (Hwang, Huang, & Tseng, 2004).

In 2007, Büyüközkan et al. used VIKOR, one of the fuzzy MCDM methods, to evaluate 10 global e-learning websites and 11 local (Büyüközkan et al., 2007).Web

site quality is generally considered multi-dimensional, and multi-criteria decision-making methods rank among conflicting criteria and options. Evaluating quality involves subjectivity and uncertainty, and because of the use of linguistic expressions, they preferred a fuzzy method. The VIKOR method is a method that provides the closest solution to the ideal solution and determines a compromised solution and orders between conflicting criteria. As a result of the research, they stated that the website ranking obtained by the VIKOR method provided maximum group decision and minimum opposition regret. They adopted fuzzy logic to hold linguistic evaluations for the criteria' importance weights and alternative ratings for more convincing and effective research.

Büyüközkan et al. adopted an axiomatic design-based approach from fuzzy group decision-making processes to evaluate e-learning website quality in 2010 (Büyüközkan et al., 2010). TOPSIS, one of the MCDM methods, was applied to verify the method proposed in the study. As an outcome of a detailed literature review, they determined the criteria for e-learning website evaluation as correct and understandable content, complete content, personalization, security, navigation, interaction, and user interface. The case study conducted with the e-learning website concluded that fuzzy AD management could add functional needs to the sorting and selection process and limit the options that do not fit the needs. In future works, it is proposed that the research be done in two stages: pre-evaluation and detailed evaluation. The specified evaluation criteria can be used in websites (e-commerce, hospital, etc.) prepared for other purposes.

Huang and Huang (2010) proposed an integrated decision model to evaluate educational websites objectively. In the application stages of the model, as the first

step, people's opinions are collected by using a questionnaire. In the second step, the evaluation is made with fuzzy clustering, a data mining technique. As a result of the empirical study they conducted to validate the model they presented, they stated that it could be beneficial for website managers and designers to create better websites. Users gained information to distinguish the site's quality (Huang & Huang, 2010).

In 2012, Nilashi and Janahmadi aimed to evaluate and prioritize the factors that affect e-learning websites' success (Nilashi & Janahmadi, 2012). In the first stage of the study, which consists of two stages, the literature review criteria were prioritized by applying the AHPmethod and fuzzy approach and divided into four main groups by the experts. The questionnaire items created in the second stage were taken from the prioritized criteria. The second survey was applied to 150 IT students in Iran, and the collected data were analyzed with the fuzzy toolbox in MATLAB. In this research, an evaluation model compatible with the literature with fuzzy logic has been developed. The website's quality, the website's content, and the website's design are presented to students, educators, and web developers for e-learning websites.

In 2018, Dani and Agrawal evaluated the quality of school education boards in Indian websites using the linear-weighted model TOPSIS methods. Their study used various web diagnostic tools to collect data from the websites regarding the evaluation criteria of response time, download time, page size, broken links, accessibility, formatting verification, design optimization, traffic, and page rank. The sequencing results obtained by analyzing the data with the linear-weighted model and TOPSIS were analyzed by statistical analysis. As a result of their research, the websites' quality rankings were reached, where the educational boards neglected the performance and quality criteria of the websites. It was emphasized that well-known

guidelines should be used when designing the school board and web developers' websites.

In their study, Deb et al. (2019) suggested the Fuzzy Logic and K-Means Clustering-based hybrid method for students researching a particular subject to rank educational websites according to the subject they are studying. First, the Fuzzy Inference System (FIS) based on fuzzy logic was established and used to find the educational website's utility value (UV) based on the students' feedback notes. Afterward, the overall utility value (GUV) of each educational website was determined. Relative frequency of visit per week (CFV), quality of subject content (QSC), and effectiveness of illustrative example (EIE) were used to evaluate educational websites. At the end of the study, they reported that the method listed the educational websites clearly and correctly and enabled the students to find the information they wanted (Deb et al., 2019).

Garg and Jain (2017) evaluated and selected e-learning websites using fuzzy set theory (FST). In two main categories, quality and E-learning specific factors, five experts evaluated using 45 selection criteria. As a result of the research, they stated that the functionality sub-criterion was the essential criterion in the first place, and the primary purpose of the study was to determine the selection criteria.

Garg, Kumar, Garg (2018) selected and ranked e-learning websites using fuzzy COPRAS. E-learning websites (8 units) were evaluated, sorted, and selected using the criteria of functionality, sustainability, usability, portability, reliability, efficiency, ease of learning, community, customization, system content, and general factors. As a result of the study, a comprehensive ranking of e-learning websites was made based on fuzzy COPRAS, fitness degree values.

Gong et al. (2021) developed a new e-learning website evaluation and selection approach called linguistic hesitant fuzzy TODIM (LHF-TODIM). In the study, LHFSs represent the experts' evaluations on e-learning websites. The TODIM approach is used to rank the evaluated e-learning websites and determine the best. The extended BWM method is presented to calculate the weights of the evaluation criteria.

# 3. METHODOLOGY

## 3.1.Fuzzy Swara Model

Kersulienė et al. (2010). They stated that it is a method that evaluates the criteria that determine them instead of alternatives. The SWARA method helps experts determine the priority status of more than one criterion (Adalı & Işık, 2017: 63).

Since incomplete and unmeasurable information causes uncertainty in decision making, Mavi et al. (2017) extended the SWARA method as Fuzzy SWARA. The fuzzy SWARA method allows the evaluation process, which is unclear due to the difficulties in decision making, to be more effective and closer to the truth (Şengül & Çağıl, 2020: 968).

The steps in the fuzzy SWARA method are the same as the SWARA method (Mavi et al., 2017) and are given below.

**Step 1:** Evaluation criteria are ordered by the decision-makers in descending order from the most important.

**Step 2:** The sj value is obtained, which Keršulienė et al. (2010) has expressed as the average value's comparative importance. For this, starting from the second criterion, the relative importance level of each criterion is determined by comparing the criterion (j) with the previous criterion (j-1).

**Step 3:** The coefficient (kj) value is provided by Equation (1).

$$\widetilde{k}_j = \begin{cases} \widetilde{1} & j = 1 \\ \tilde{s}_j + \widetilde{1} & j > 1 \end{cases} \quad (1)$$

**Step 4:** The recalculated weight (qj) is obtained from Equation (2).

$$\tilde{q}_j = \begin{cases} 1 & j = 1 \\ \frac{\tilde{q}_{j-1}}{\tilde{k}_j} & j > 1 \end{cases} \quad (2)$$

**Step 5:** Equation (3) is used to calculate the fuzzy weights (wj) of the criteria.

$$\tilde{w}_j = \frac{\tilde{q}_j}{\sum_{k=1}^{n} \tilde{q}_k} \quad (3)$$

$\widetilde{W}_j = \left(\widetilde{W}_j^l, \widetilde{W}_j^m, \widetilde{W}_j^u\right)$ is the relative importance weight of the jth criterion. The triangular fuzzy numbers used in the calculation will be shown as $A_1 = (l_1, m_1, u_1)$ as $l_1 \leq m_1 \leq u_1$ (Mavi et al., 2017; Şengül & Çağıl, 2020). The arithmetic equations of triangular fuzzy numbers are given below.

The addition of two fuzzy numbers is defined as given in Equation (4):

$$A1 \oplus A2 = (l_1 + l_2, m_1 + m_2, u_1 + u_2) \quad (4)$$

The subtraction of two fuzzy numbers is defined as given in Equation (5):

$$A1 \ominus A2 = (l_1 - u_2, m_1 - m_2, u_1 - l_2) \quad (5)$$

The product of two fuzzy numbers is defined as given in Equation (6):

$$A1 \otimes A2 = (l_1 l_2, m_1 m_2, u_1 u_2) \quad (6)$$

Division of two fuzzy numbers is defined as given in Equation (7):

$$A1 \oslash A2 = (l_1/u_2, m_1/m_2, u_1/l_2) \quad (7)$$

**Step 6:** Equation (8) is used to defuzzify the fuzzy criterion weights (Mavi et al., 2017).

$$w_j = \frac{(w_j^u - w_j^l) + (w_j^m - w_j^l)}{3} + w_j^l \quad (8)$$

### 3.2. WASPAS-F Model

WASPAS, Zavadskas et al. (2012) as a multi-criteria decision-making method. The steps of the fuzzy WASPAS method are described by Turkis et al. (2015) as defined in their study. It is obtained by combining the results of two different models, "Weighted Sum Model" and "Weighted Product Model". WSM is a method used to determine the weighted sum of the criteria and the total score of the alternatives. On the other hand, WPM was developed to prevent alternatives with weak criterion values (Turkis et al., 2015: 879).

The steps of the fuzzy WASPAS method are as follows.

**Step 1:** Constructing the fuzzy decision evaluation matrix: x̃_ij in the decision matrix inputs i. alternative j. is the fuzzy performance value and w̃_ij weight according to the criterion (Toklu et al., 2020: 131). The number of alternatives is m, the number of criteria is n.

$$\widetilde{\boldsymbol{X}} = \begin{bmatrix} \widetilde{\boldsymbol{x}}_{\boldsymbol{11}} & \cdots & \widetilde{\boldsymbol{x}}_{\boldsymbol{1j}} & \cdots & \widetilde{\boldsymbol{x}}_{\boldsymbol{1n}} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \widetilde{\boldsymbol{x}}_{\boldsymbol{i1}} & \cdots & \widetilde{\boldsymbol{x}}_{\boldsymbol{ij}} & \cdots & \widetilde{\boldsymbol{x}}_{\boldsymbol{in}} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \widetilde{\boldsymbol{x}}_{\boldsymbol{m1}} & \cdots & \widetilde{\boldsymbol{x}}_{\boldsymbol{mj}} & \cdots & \widetilde{\boldsymbol{x}}_{\boldsymbol{mn}} \end{bmatrix}; \boldsymbol{i} = \overline{\boldsymbol{1,m}}, \boldsymbol{j} = \overline{\boldsymbol{1,n}}, \tag{9}$$

**Step 2:** Normalization is applied to $\tilde{x}_{ij}$ values to create a normalized decision matrix.

$$\widetilde{\widetilde{\boldsymbol{x}}}_{\boldsymbol{ij}} = \begin{cases} \dfrac{\widetilde{\boldsymbol{x}}_{\boldsymbol{ij}}}{\max\limits_{\boldsymbol{i}} \widetilde{\boldsymbol{x}}_{\boldsymbol{ij}}} & \boldsymbol{if}\ \max\limits_{\boldsymbol{i}} \widetilde{\boldsymbol{x}}_{\boldsymbol{ij}}\ \textbf{is preferable}, \\ \dfrac{\min\limits_{\boldsymbol{i}} \widetilde{\boldsymbol{x}}_{\boldsymbol{ij}}}{\widetilde{\boldsymbol{x}}_{\boldsymbol{ij}}} & \boldsymbol{if}\ \min\limits_{\boldsymbol{i}} \widetilde{\boldsymbol{x}}_{\boldsymbol{ij}}\ \textbf{is preferable}; \end{cases} \quad \boldsymbol{i} = \overline{\boldsymbol{1,m}}, \boldsymbol{j} = \overline{\boldsymbol{1,n}}. \tag{10}$$

**Step 3a:** The weighted normalized fuzzy decision matrix $(\tilde{\tilde{X}}_q)$ for the Weighted Sum Model (WSM) is calculated as follows.

$$\widetilde{\widetilde{X}}_q = \begin{bmatrix} \widetilde{\widetilde{x}}_{11} & \cdots & \widetilde{\widetilde{x}}_{1j} & \cdots & \widetilde{\widetilde{x}}_{1n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \widetilde{\widetilde{x}}_{i1} & \cdots & \widetilde{\widetilde{x}}_{ij} & \cdots & \widetilde{\widetilde{x}}_{in} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \widetilde{\widetilde{x}}_{m1} & \cdots & \widetilde{\widetilde{x}}_{mj} & \cdots & \widetilde{\widetilde{x}}_{mn} \end{bmatrix}; \widetilde{\widetilde{x}}_{ij} = \widetilde{\widetilde{x}}_{ij}\widetilde{w}_j, i = \overline{1,m}, j = \overline{1,n}. \quad (11)$$

**Step 3b:** The weighted normalized fuzzy decision matrix ($\tilde{\tilde{X}}_p$) for the Weighted Product Model (WPM) is calculated as follows.

$$\widetilde{\widetilde{X}}_p = \begin{bmatrix} \widetilde{\widetilde{\widetilde{x}}}_{11} & \cdots & \widetilde{\widetilde{\widetilde{x}}}_{1j} & \cdots & \widetilde{\widetilde{\widetilde{x}}}_{1n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \widetilde{\widetilde{\widetilde{x}}}_{i1} & \cdots & \widetilde{\widetilde{\widetilde{x}}}_{ij} & \cdots & \widetilde{\widetilde{\widetilde{x}}}_{in} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \widetilde{\widetilde{\widetilde{x}}}_{m1} & \cdots & \widetilde{\widetilde{\widetilde{x}}}_{mj} & \cdots & \widetilde{\widetilde{\widetilde{x}}}_{mn} \end{bmatrix}; \widetilde{\widetilde{\widetilde{x}}}_{ij} = \widetilde{\widetilde{x}}_{ij}^{\widetilde{w}_j}, i = \overline{1,m}, j = \overline{1,n}, \quad (12)$$

**Step 4:** The value of the optimality function is calculated with the following equations. For each alternative to the Weighted Sum Model (WSM):

$$\widetilde{Q}_i = \sum_{j=1}^{n} \widetilde{\widetilde{x}}_{ij}, i = \overline{1,m}, \quad (13)$$

For each Weighted Product Model (WPM) alternative:

$$\widetilde{P}_i = \prod_{j=1}^{n} \widetilde{\widetilde{\widetilde{x}}}_{ij}, i = \overline{1,m}. \quad (14)$$

The following equations are used to clarify the $\tilde{Q}_i$ and $\tilde{P}_i$ values, which are the fuzzy performance measurement results of each alternative.

$$Q_i = \frac{1}{3}\left(Q_{ia} + Q_{i\beta} + Q_{i\gamma}\right). \quad (15)$$

$$P_i = \frac{1}{3}\left(P_{ia} + P_{i\beta} + P_{i\gamma}\right). \quad (16)$$

**Step 5:** The integrated utility function value of the fuzzy WASPAS method is calculated using the equation below.

$$\boldsymbol{K_i = \lambda \sum_{j=1}^{m} Q_i + (1-\lambda) \sum_{j=1}^{m} P_i}, \boldsymbol{\lambda = 0, \ldots, 1, 0 \leq K_i \geq 1}. \quad (17)$$

The λ value is calculated based on the assumption that all alternatives' WSM and WPM values should be equal.

$$\boldsymbol{\lambda = \frac{\sum_{i=1}^{m} P_i}{\sum_{i=1}^{m} Q_i + \sum_{i=1}^{m} P_i}}. \quad (18)$$

### 3.3. Instruments

The forms used to collect the experts' demographic information and evaluate the criteria and educational website designs based on the determined criteria and their explanations are given in Appendix 2.

# 4. APPLICATION

This section evaluates the weights of the design criteria with the Fuzzy SWARA method and the design of educational websites with the Fuzzy WASPAS method. The design criteria were determined as visual aspect (C1), navigation (C2), organization (C3), interactivity (C4), accessibility (C5), content (C6) as a result of a detailed literature review. The educational websites to be evaluated according to these design criteria are given in the Table. The information of the experts who will make the evaluation is available in Table 4.1. Calculations are carried out using the Microsoft Excel program.

*Table 4.3.31 Demographic characteristics of decision-makers*

| | **Job** | **Professional Experience** |
|---|---|---|
| E1 | Web Design Specialist | Eight years |
| E2 | Web Design Specialist | Four years |
| E3 | Web Design Specialist | Four years |
| E4 | ICT Teacher | Three years |
| E5 | ICT Teacher | Eight years |
| E6 | ICT Teacher | Seven years |

### 4.1.Determination of Linguistic Variables

Linguistic variables are one of the basic concepts of fuzzy logic that includes verbal expressions. In a multi-criteria, fuzzy decision-making environment, it is necessary to define linguistic variables to select the best alternative for the target with few decision-makers and alternative groups. Decision-makers use linguistic variables to calculate the importance of the criterion and the importance of alternatives according to other criteria (Eleren, 2007: 287). The linguistic variables used for evaluating the criteria with the fuzzy SWARA method are shown in Table 4.1.1, and

the linguistic variables used for the WASPAS-F method are shown in Table 4.1.2 with their triangular fuzzy number equivalents.

*Table 4.1.1 Linguistic variables for criterion weights (Chang, 1996)*

| **Linguistic variable** | **Fuzzy Number** |
|---|---|
| Equally important (EI) | (1,1,1) |
| Moderately less important (MI) | (2/3,1,3/2) |
| Less important (LI) | (2/5,1/2,2/3) |
| Very less important (VI) | (2/7,1/3,2/5) |
| Much less important (MuI) | (2/9,1/4,2/7) |

*Table 4.1.2 Linguistic variables used in the evaluation of educational websites (Sun, 2010)*

| **Linguistic variable** | **Triangular Fuzzy Number** |
|---|---|
| Very Poor (VP) | (0,1,3) |
| Poor (P) | (1,3,5) |
| Fair (F) | (3,5,7) |
| Good (G) | (5,7,9) |
| Vey Good (VG) | (7,9,10) |

## 4.2. Determination of Criterion Weights with Fuzzy SWARA Method

Fuzzy SWARA was preferred because it is a method that is easy to implement and has less transaction cost (Şengül & Çağıl, 2020) where the opinions of decision-makers are essential. Six decision-makers evaluated the websites using linguistic variables (Table 4.2.1).

*Table 4.2.1 Criteria order of importance of decision makers*

| E1 | | E2 | | E3 | | E4 | | E5 | | E6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **C1** | - | **C5** | - | **C6** | - | **C5** | - | **C5** | - | **C5** | - |
| **C6** | EI | **C1** | EI | **C5** | EI | **C1** | MI | **C2** | MuI | **C2** | MuI |
| **C5** | MI | **C6** | EI | **C1** | EI | **C6** | EI | **C6** | MuI | **C6** | MuI |
| **C4** | EI | **C2** | MI | **C2** | LI | **C2** | LI | **C1** | VI | **C1** | VI |
| **C3** | LI | **C3** | LI | **C3** | MI | **C3** | LI | **C3** | VI | **C4** | VI |
| **C2** | MI | **C4** | VI | **C4** | MI | **C4** | VI | **C4** | LI | **C3** | LI |

The sj (comparative importance of average value) value obtained by converting the linguistic variables given in Table 4.1.1 to the fuzzy number equivalents in the order of importance of the criteria is shown in Table 4.2.2 and Table 4.2.3.

*Table 4.2.2 sj values of the criteria E1- E3*

| E1 | | | | E2 | | | | E3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **l** | **m** | **u** | | **l** | **m** | **u** | | **l** | **M** | **u** |
| **C1** | - | - | - | **C5** | - | - | - | **C6** | - | - | - |
| **C6** | 1,00 | 1,00 | 1,00 | **C1** | 1,00 | 1,00 | 1,00 | **C5** | 1,00 | 1,00 | 1,00 |
| **C5** | 0,67 | 1,00 | 1,50 | **C6** | 1,00 | 1,00 | 1,00 | **C1** | 1,00 | 1,00 | 1,00 |
| **C4** | 1,00 | 1,00 | 1,00 | **C2** | 0,67 | 1,00 | 1,50 | **C2** | 0,40 | 0,50 | 0,67 |
| **C3** | 0,40 | 0,50 | 0,67 | **C3** | 0,40 | 0,50 | 0,67 | **C3** | 0,67 | 1,00 | 1,50 |
| **C2** | 0,67 | 1,00 | 1,50 | **C4** | 0,29 | 0,33 | 0,40 | **C4** | 0,67 | 1,00 | 1,50 |

*Table 4.2.3 sj values of the criteria E4- E6*

| E4 | | | | E5 | | | | E6 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **l** | **m** | **u** | | **l** | **m** | **u** | | **l** | **M** | **u** |
| **C5** | - | - | - | **C5** | - | - | - | **C5** | - | - | - |
| **C1** | 0,67 | 1,00 | 1,50 | **C2** | 0,22 | 0,25 | 0,29 | **C2** | 0,22 | 0,25 | 0,29 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **C6** | 1,00 | 1,00 | 1,00 | **C6** | 0,22 | 0,25 | 0,29 | **C6** | 0,22 | 0,25 | 0,29 |
| **C2** | 0,40 | 0,50 | 0,67 | **C1** | 0,29 | 0,33 | 0,40 | **C1** | 0,29 | 0,33 | 0,40 |
| **C3** | 0,40 | 0,50 | 0,67 | **C3** | 0,29 | 0,33 | 0,40 | **C4** | 0,29 | 0,33 | 0,40 |
| **C4** | 0,29 | 0,33 | 0,40 | **C4** | 0,40 | 0,50 | 0,67 | **C3** | 0,40 | 0,50 | 0,67 |

Equation 2.1 is used to find the coefficient (kj) value, and Table 4.2.4 and Table 4.2.5 are given. The recalculated weight (qj) value was calculated using Equation 2.2 (Table 4.2.6 and Table 4.2.7). Wj fuzzy weights were obtained by Equation 2.3 (Table 4.2.8 and Table 4.2.9).

*Table 4.2.4 kj coefficient values of the criteria E1- E3*

| **E1** | | | | **E2** | | | | **E3** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **l** | **m** | **u** | | **l** | **m** | **u** | | **l** | **M** | **u** |
| **C1** | 1 | 1 | 1 | **C5** | 1 | 1 | 1 | **C6** | 1 | 1 | 1 |
| **C6** | 2,00 | 2,00 | 2,00 | **C1** | 2,00 | 2,00 | 2,00 | **C5** | 2,00 | 2,00 | 2,00 |
| **C5** | 1,67 | 2,00 | 2,50 | **C6** | 2,00 | 2,00 | 2,00 | **C1** | 2,00 | 2,00 | 2,00 |
| **C4** | 2,00 | 2,00 | 2,00 | **C2** | 1,67 | 2,00 | 2,50 | **C2** | 1,40 | 1,50 | 1,67 |
| **C3** | 1,40 | 1,50 | 1,67 | **C3** | 1,40 | 1,50 | 1,67 | **C3** | 1,67 | 2,00 | 2,50 |
| **C2** | 1,67 | 2,00 | 2,50 | **C4** | 1,29 | 1,33 | 1,40 | **C4** | 1,67 | 2,00 | 2,50 |

*Table 4.2.5 kj coefficient values of the criteria E4- E6*

| **E4** | | | | **E5** | | | | **E6** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **l** | **m** | **u** | | **l** | **m** | **u** | | **l** | **M** | **u** |
| **C5** | 1 | 1 | 1 | **C5** | 1 | 1 | 1 | **C5** | 1 | 1 | 1 |
| **C1** | 1,67 | 2,00 | 2,50 | **C2** | 1,22 | 1,25 | 1,29 | **C2** | 1,22 | 1,25 | 1,29 |
| **C6** | 2,00 | 2,00 | 2,00 | **C6** | 1,22 | 1,25 | 1,29 | **C6** | 1,22 | 1,25 | 1,29 |
| **C2** | 1,40 | 1,50 | 1,67 | **C1** | 1,29 | 1,33 | 1,40 | **C1** | 1,29 | 1,33 | 1,40 |
| **C3** | 1,40 | 1,50 | 1,67 | **C3** | 1,29 | 1,33 | 1,40 | **C4** | 1,29 | 1,33 | 1,40 |
| **C4** | 1,29 | 1,33 | 1,40 | **C4** | 1,40 | 1,50 | 1,67 | **C3** | 1,40 | 1,50 | 1,67 |

*Table 4.2.6 The recalculated weight (qj) value (E1- E3)*

| E1 | | | | E2 | | | | E3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **l** | **m** | **u** | | **l** | **m** | **u** | | **l** | **M** | **u** |
| **C1** | 1,00 | 1,00 | 1,00 | **C5** | 1,00 | 1,00 | 1,00 | **C6** | 1,00 | 1,00 | 1,00 |
| **C6** | 0,50 | 0,50 | 0,50 | **C1** | 0,50 | 0,50 | 0,50 | **C5** | 0,50 | 0,50 | 0,50 |
| **C5** | 0,30 | 0,25 | 0,20 | **C6** | 0,25 | 0,25 | 0,25 | **C1** | 0,25 | 0,25 | 0,25 |
| **C4** | 0,150 | 0,125 | 0,100 | **C2** | 0,150 | 0,125 | 0,100 | **C2** | 0,179 | 0,167 | 0,150 |
| **C3** | 0,107 | 0,083 | 0,060 | **C3** | 0,107 | 0,083 | 0,060 | **C3** | 0,107 | 0,083 | 0,060 |
| **C2** | 0,064 | 0,042 | 0,024 | **C4** | 0,083 | 0,063 | 0,043 | **C4** | 0,064 | 0,042 | 0,024 |

*Table 4.2.7 The recalculated weight (qj) value (E4- E6)*

| E4 | | | | E5 | | | | E6 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **l** | **m** | **u** | | **l** | **m** | **u** | | **l** | **M** | **u** |
| **C5** | 1,00 | 1,00 | 1,00 | **C5** | 1,00 | 1,00 | 1,00 | **C5** | 1,00 | 1,00 | 1,00 |
| **C1** | 0,60 | 0,50 | 0,40 | **C2** | 0,818 | 0,800 | 0,778 | **C2** | 0,818 | 0,800 | 0,778 |
| **C6** | 0,30 | 0,25 | 0,20 | **C6** | 0,669 | 0,640 | 0,605 | **C6** | 0,669 | 0,640 | 0,605 |
| **C2** | 0,214 | 0,167 | 0,120 | **C1** | 0,521 | 0,480 | 0,432 | **C1** | 0,521 | 0,480 | 0,432 |
| **C3** | 0,153 | 0,111 | 0,072 | **C3** | 0,405 | 0,360 | 0,309 | **C4** | 0,405 | 0,360 | 0,309 |
| **C4** | 0,119 | 0,083 | 0,051 | **C4** | 0,289 | 0,240 | 0,185 | **C3** | 0,289 | 0,240 | 0,185 |

*Table 4.2.8 wj values of criteria (E1- E3)*

| E1 | | | | E2 | | | | E3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **l** | **m** | **u** | | **l** | **m** | **u** | | **l** | **M** | **u** |
| **C1** | 0,471 | 0,500 | 0,531 | **C5** | 0,478 | 0,495 | 0,512 | **C6** | 0,476 | 0,476 | 0,504 |
| **C6** | 0,236 | 0,250 | 0,265 | **C1** | 0,239 | 0,247 | 0,256 | **C5** | 0,238 | 0,238 | 0,252 |
| **C5** | 0,141 | 0,125 | 0,106 | **C6** | 0,120 | 0,124 | 0,128 | **C1** | 0,119 | 0,119 | 0,126 |
| **C4** | 0,071 | 0,063 | 0,053 | **C2** | 0,072 | 0,062 | 0,051 | **C2** | 0,085 | 0,079 | 0,076 |
| **C3** | 0,051 | 0,042 | 0,032 | **C3** | 0,051 | 0,041 | 0,031 | **C3** | 0,051 | 0,040 | 0,030 |
| **C2** | 0,030 | 0,021 | 0,013 | **C4** | 0,040 | 0,031 | 0,022 | **C4** | 0,031 | 0,020 | 0,012 |

*Table 4.2.9 wj values of criteria (E4- E6)*

| E4 | | | | E5 | | | | E6 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **l** | **m** | **u** | | **l** | **m** | **u** | | **l** | **M** | **u** |
| **C5** | 0,419 | 0,474 | 0,542 | **C5** | 0,270 | 0,284 | 0,302 | **C5** | 0,270 | 0,284 | 0,302 |
| **C1** | 0,251 | 0,237 | 0,217 | **C2** | 0,221 | 0,227 | 0,235 | **C2** | 0,221 | 0,227 | 0,235 |
| **C6** | 0,126 | 0,118 | 0,108 | **C6** | 0,181 | 0,182 | 0,183 | **C6** | 0,181 | 0,182 | 0,183 |
| **C2** | 0,090 | 0,079 | 0,065 | **C1** | 0,141 | 0,136 | 0,131 | **C1** | 0,141 | 0,136 | 0,131 |
| **C3** | 0,064 | 0,053 | 0,039 | **C3** | 0,109 | 0,102 | 0,093 | **C4** | 0,109 | 0,102 | 0,093 |
| **C4** | 0,050 | 0,039 | 0,028 | **C4** | 0,078 | 0,068 | 0,056 | **C3** | 0,078 | 0,068 | 0,056 |

Table 4.2.10 is shown by taking the geometric mean to determine the final fuzzy weights of the criteria. The clarification process was performed using Equation 2.8 (Mavi et al., 2017), and Table 4.2.11 is available.

*Table 4.2.10 The arithmetic mean of the fuzzy weights of the criteria*

| **Criteria** | **Geometric Average of the Value $\widetilde{W}_j$** | | |
|---|---|---|---|
| | **l** | **m** | **u** |
| **C1** | 0,201 | 0,200 | 0,200 |
| **C2** | 0,097 | 0,086 | 0,075 |
| **C3** | 0,065 | 0,054 | 0,043 |
| **C4** | 0,058 | 0,047 | 0,036 |
| **C5** | 0,281 | 0,287 | 0,296 |
| **C6** | 0,195 | 0,197 | 0,199 |

*Table 4.2.11 Clarified importance weights of criteria*

| | **Criteria Name** | **Clarified Weights** |
|---|---|---|
| **C1** | **Visual Aspects** | 0,201 |
| **C2** | **Navigation** | 0,086 |
| **C3** | **Organization** | 0,054 |

| | | |
|---|---|---|
| **C4** | **Interactivity** | 0,047 |
| **C5** | **Accessibility** | 0,288 |
| **C6** | **Content** | 0,197 |

### 4.3.Application of the WASPAS-F Method

The importance weights obtained with Fuzzy SWARA were used to evaluate the design of educational websites with the Fuzzy WASPAS method. Our experts, who evaluated the criteria, evaluated the educational websites according to the criteria with the help of linguistic variables (Table 4.1.2). Evaluation results were converted into fuzzy numbers and their geometric averages were taken (Koç Ustalı & Tosun, 2019) and the initial fuzzy decision matrix was obtained (Table 4.3.1). The evaluation result of each expert is included in Appendix 3.

*Table 4.3.1 Initial fuzzy decision matrix*

| | | **C1** | **C2** | **C3** | **C4** | **C5** | **C6** |
|---|---|---|---|---|---|---|---|
| **W1** | **l** | 4,189 | 4,594 | 4,220 | 1,362 | 4,465 | 5,289 |
| | **m** | 6,526 | 6,619 | 6,259 | 3,636 | 6,527 | 7,300 |
| | **u** | 8,252 | 8,631 | 8,277 | 5,916 | 8,424 | 9,160 |
| **W2** | **l** | 2,143 | 4,724 | 3,636 | 2,143 | 1,637 | 2,008 |
| | **m** | 4,560 | 6,807 | 5,916 | 4,560 | 3,959 | 4,559 |
| | **u** | 6,901 | 8,574 | 7,776 | 6,901 | 6,257 | 6,760 |
| **W3** | **l** | 2,857 | 5,141 | 1,840 | 2,206 | 3,338 | 2,405 |
| | **m** | 5,552 | 7,199 | 4,309 | 4,690 | 5,593 | 4,962 |
| | **u** | 7,774 | 8,940 | 6,482 | 6,855 | 7,457 | 7,149 |
| **W4** | **l** | 0,942 | 2,734 | 2,285 | 3,459 | 3,876 | 3,741 |
| | **m** | 2,979 | 4,860 | 4,465 | 5,517 | 5,917 | 5,999 |
| | **u** | 5,141 | 6,903 | 6,527 | 7,430 | 7,938 | 7,967 |
| **W5** | **l** | 0,599 | 2,095 | 2,734 | 1,372 | 2,508 | 3,268 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **m** | 2,491 | 4,220 | 4,860 | 3,535 | 4,594 | 5,289 |
| | **u** | 4,724 | 6,259 | 6,903 | 5,752 | 6,619 | 7,300 |
| **W6** | **l** | 1,096 | 2,895 | 3,268 | 1,590 | 1,906 | 1,908 |
| | **m** | 3,291 | 5,069 | 5,289 | 3,903 | 4,102 | 4,250 |
| | **u** | 5,458 | 7,026 | 7,300 | 6,106 | 6,172 | 6,458 |
| **W7** | **l** | 0,777 | 1,207 | 1,588 | 0,638 | 2,095 | 1,747 |
| | **m** | 2,734 | 3,268 | 3,767 | 2,508 | 4,220 | 3,876 |
| | **u** | 4,860 | 5,289 | 5,835 | 4,594 | 6,259 | 5,917 |
| **W8** | **l** | 2,857 | 3,338 | 2,875 | 2,143 | 2,405 | 4,220 |
| | **m** | 5,552 | 5,593 | 5,213 | 4,560 | 4,962 | 6,259 |
| | **u** | 7,774 | 7,457 | 7,225 | 6,901 | 7,149 | 8,277 |

The criteria are normalized with the maximization equation (Equation 10) as the utility criterion (Table 4.3.2). The results of WSM (Table 4.3.3) by applying Equation 11 to the normalized decision matrix and WPM (Table 4.3.4) by applying Equation 12 were calculated.

*Table 4.3.2 Normalized fuzzy decision matrix*

| | | **C1** | **C2** | **C3** | **C4** | **C5** | **C6** |
|---|---|---|---|---|---|---|---|
| **W1** | **l** | 0,508 | 0,514 | 0,510 | 0,183 | 0,530 | 0,577 |
| | **m** | 0,791 | 0,740 | 0,756 | 0,489 | 0,775 | 0,797 |
| | **u** | 1,000 | 0,965 | 1,000 | 0,796 | 1,000 | 1,000 |
| **W2** | **l** | 0,260 | 0,528 | 0,439 | 0,288 | 0,194 | 0,219 |
| | **m** | 0,553 | 0,761 | 0,715 | 0,614 | 0,470 | 0,498 |
| | **u** | 0,836 | 0,959 | 0,939 | 0,929 | 0,743 | 0,738 |
| **W3** | **l** | 0,346 | 0,575 | 0,222 | 0,297 | 0,396 | 0,263 |
| | **m** | 0,673 | 0,805 | 0,521 | 0,631 | 0,664 | 0,542 |
| | **u** | 0,942 | 1,000 | 0,783 | 0,923 | 0,885 | 0,780 |
| **W4** | **l** | 0,114 | 0,306 | 0,276 | 0,466 | 0,460 | 0,408 |
| | **m** | 0,361 | 0,544 | 0,539 | 0,743 | 0,702 | 0,655 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **u** | 0,623 | 0,772 | 0,789 | 1,000 | 0,942 | 0,870 |
| **W5** | **l** | 0,073 | 0,234 | 0,330 | 0,185 | 0,298 | 0,357 |
| | **m** | 0,302 | 0,472 | 0,587 | 0,476 | 0,545 | 0,577 |
| | **u** | 0,572 | 0,700 | 0,834 | 0,774 | 0,786 | 0,797 |
| **W6** | **l** | 0,133 | 0,324 | 0,395 | 0,214 | 0,226 | 0,208 |
| | **m** | 0,399 | 0,567 | 0,639 | 0,525 | 0,487 | 0,464 |
| | **u** | 0,661 | 0,786 | 0,882 | 0,822 | 0,733 | 0,705 |
| **W7** | **l** | 0,094 | 0,135 | 0,192 | 0,086 | 0,249 | 0,191 |
| | **m** | 0,331 | 0,366 | 0,455 | 0,338 | 0,501 | 0,423 |
| | **u** | 0,589 | 0,592 | 0,705 | 0,618 | 0,743 | 0,646 |
| **W8** | **l** | 0,346 | 0,373 | 0,347 | 0,288 | 0,285 | 0,461 |
| | **m** | 0,673 | 0,626 | 0,630 | 0,614 | 0,589 | 0,683 |
| | **u** | 0,942 | 0,834 | 0,873 | 0,929 | 0,849 | 0,904 |

*Table 4.3.3 Weighted normalized decision matrix for the Weighted Sum Model*

| | | **C1** | **C2** | **C3** | **C4** | **C5** | **C6** | **Toplam** | **Q(i)** | **∑ Q(i)** |
|---|---|---|---|---|---|---|---|---|---|---|
| **W1** | **l** | 0,102 | 0,044 | 0,027 | 0,009 | 0,153 | 0,114 | 0,448 | 0,658 | 3,942 |
| | **m** | 0,159 | 0,064 | 0,041 | 0,023 | 0,223 | 0,157 | 0,666 | | |
| | **u** | 0,201 | 0,083 | 0,054 | 0,037 | 0,288 | 0,197 | 0,860 | | |
| **W2** | **l** | 0,052 | 0,045 | 0,024 | 0,013 | 0,056 | 0,043 | 0,234 | 0,471 | |
| | **m** | 0,111 | 0,065 | 0,038 | 0,029 | 0,135 | 0,098 | 0,477 | | |
| | **u** | 0,168 | 0,082 | 0,051 | 0,043 | 0,214 | 0,145 | 0,703 | | |
| **W3** | **l** | 0,069 | 0,049 | 0,012 | 0,014 | 0,114 | 0,052 | 0,311 | 0,546 | |
| | **m** | 0,135 | 0,069 | 0,028 | 0,029 | 0,191 | 0,107 | 0,560 | | |
| | **u** | 0,189 | 0,086 | 0,042 | 0,043 | 0,255 | 0,154 | 0,769 | | |
| **W4** | **l** | 0,023 | 0,026 | 0,015 | 0,022 | 0,133 | 0,080 | 0,299 | 0,512 | |
| | **m** | 0,072 | 0,047 | 0,029 | 0,035 | 0,202 | 0,129 | 0,514 | | |
| | **u** | 0,125 | 0,066 | 0,042 | 0,047 | 0,272 | 0,171 | 0,723 | | |
| **W5** | **l** | 0,015 | 0,020 | 0,018 | 0,009 | 0,086 | 0,070 | 0,217 | 0,427 | |
| | **m** | 0,061 | 0,041 | 0,032 | 0,022 | 0,157 | 0,114 | 0,426 | | |
| | **u** | 0,115 | 0,060 | 0,045 | 0,036 | 0,226 | 0,157 | 0,639 | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **W6** | **l** | 0,027 | 0,028 | 0,021 | 0,010 | 0,065 | 0,041 | 0,192 | 0,416 | |
| | **m** | 0,080 | 0,049 | 0,034 | 0,025 | 0,140 | 0,091 | 0,419 | | |
| | **u** | 0,133 | 0,068 | 0,047 | 0,038 | 0,211 | 0,139 | 0,636 | | |
| **W7** | **l** | 0,019 | 0,012 | 0,010 | 0,004 | 0,072 | 0,038 | 0,154 | 0,366 | |
| | **m** | 0,066 | 0,031 | 0,024 | 0,016 | 0,144 | 0,083 | 0,366 | | |
| | **u** | 0,118 | 0,051 | 0,038 | 0,029 | 0,214 | 0,127 | 0,577 | | |
| **W8** | **l** | 0,069 | 0,032 | 0,019 | 0,013 | 0,082 | 0,091 | 0,307 | 0,545 | |
| | **m** | 0,135 | 0,054 | 0,034 | 0,029 | 0,170 | 0,135 | 0,556 | | |
| | **u** | 0,189 | 0,072 | 0,047 | 0,043 | 0,245 | 0,178 | 0,773 | | |

*Table 4.3.4 Weighted normalized decision matrix for the Weighted Product Model*

| | | **C1** | **C2** | **C3** | **C4** | **C5** | **C6** | **Çarpım** | **P(i)** | **∑ P(i)** |
|---|---|---|---|---|---|---|---|---|---|---|
| **W1** | **l** | 0,873 | 0,944 | 0,964 | 0,924 | 0,833 | 0,898 | 0,549 | 0,774 | 4,738 |
| | **m** | 0,954 | 0,974 | 0,985 | 0,967 | 0,929 | 0,956 | 0,787 | | |
| | **u** | 1,000 | 0,997 | 1,000 | 0,989 | 1,000 | 1,000 | 0,986 | | |
| **W2** | **l** | 0,763 | 0,947 | 0,957 | 0,944 | 0,624 | 0,742 | 0,302 | 0,570 | |
| | **m** | 0,888 | 0,977 | 0,982 | 0,977 | 0,804 | 0,872 | 0,584 | | |
| | **u** | 0,965 | 0,996 | 0,997 | 0,997 | 0,918 | 0,942 | 0,825 | | |
| **W3** | **l** | 0,808 | 0,954 | 0,922 | 0,945 | 0,766 | 0,769 | 0,395 | 0,654 | |
| | **m** | 0,924 | 0,982 | 0,966 | 0,979 | 0,889 | 0,886 | 0,675 | | |
| | **u** | 0,988 | 1,000 | 0,987 | 0,996 | 0,965 | 0,952 | 0,893 | | |
| **W4** | **l** | 0,647 | 0,903 | 0,933 | 0,965 | 0,799 | 0,838 | 0,353 | 0,602 | |
| | **m** | 0,815 | 0,949 | 0,967 | 0,986 | 0,903 | 0,920 | 0,613 | | |
| | **u** | 0,909 | 0,978 | 0,987 | 1,000 | 0,983 | 0,973 | 0,840 | | |
| **W5** | **l** | 0,591 | 0,883 | 0,942 | 0,924 | 0,705 | 0,816 | 0,261 | 0,513 | |
| | **m** | 0,786 | 0,937 | 0,972 | 0,966 | 0,840 | 0,898 | 0,522 | | |
| | **u** | 0,894 | 0,970 | 0,990 | 0,988 | 0,933 | 0,956 | 0,757 | | |
| **W6** | **l** | 0,667 | 0,908 | 0,951 | 0,930 | 0,652 | 0,734 | 0,256 | 0,513 | |
| | **m** | 0,832 | 0,952 | 0,976 | 0,970 | 0,813 | 0,860 | 0,524 | | |
| | **u** | 0,920 | 0,979 | 0,993 | 0,991 | 0,914 | 0,934 | 0,757 | | |
| **W7** | **l** | 0,623 | 0,842 | 0,915 | 0,892 | 0,670 | 0,722 | 0,207 | 0,455 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **m** | 0,801 | 0,917 | 0,959 | 0,951 | 0,819 | 0,844 | 0,463 | | |
| | **u** | 0,899 | 0,956 | 0,981 | 0,978 | 0,918 | 0,918 | 0,695 | | |
| **W8** | **l** | 0,808 | 0,919 | 0,945 | 0,944 | 0,697 | 0,858 | 0,396 | 0,656 | |
| | **m** | 0,924 | 0,960 | 0,975 | 0,977 | 0,858 | 0,928 | 0,674 | | |
| | **u** | 0,988 | 0,985 | 0,993 | 0,997 | 0,954 | 0,980 | 0,900 | | |

Finally, the results and ranking obtained by calculating the λ value calculated as 0.546 and the Ki value are shown in Table 4.3.5.

*Table 4.3.5 Integrated utility function values of the fuzzy WASPAS approach.*

| | **P(i)** | **Q(i)** | **λ** | **Ki** | **Sıralama** |
|---|---|---|---|---|---|
| **W1** | 0,774 | 0,658 | 0,546 | 0,711 | 1 |
| **W2** | 0,570 | 0,471 | | 0,516 | 5 |
| **W3** | 0,654 | 0,546 | | 0,595 | 3 |
| **W4** | 0,602 | 0,512 | | 0,553 | 4 |
| **W5** | 0,513 | 0,427 | | 0,466 | 6 |
| **W6** | 0,513 | 0,416 | | 0,460 | 7 |
| **W7** | 0,455 | 0,366 | | 0,406 | 8 |
| **W8** | 0,656 | 0,545 | | 0,596 | 2 |

# CONCLUSION

In this research, the designs of the educational websites used recently were evaluated with Fuzzy SWARA and Fuzzy WASPAS methods. Fuzzy Swara was applied to find the importance weights of the determining design criteria. It was seen that the importance weight of the accessibility criterion was higher than the other criteria. The importance weights of all criteria are given in Table 4.2.11. The order of criteria is Accessibility, Visual Aspect, Content, Navigation, Organization, and Interactivity. As a result of six experts' evaluation of educational websites using the criteria (Table 4.3.5), the khan academy site was ranked first. It was observed that it was more suitable for the design criteria. When this ranking and the click rates given in Table 2.5.2 and Table 2.5.3 are compared, it has been observed that the website with the highest number of clicks, evvelcevap.com, ranks fifth in the design evaluation. This difference may be due to different parameters such as search engine optimization (SEO), number of backlinks, keyword usage, and quality content of websites. Search engines act as a bridge between the user and the website, and all of the techniques used to rank higher in search engines are called SEO. Yüksel and Tolon (2019) evaluated the steps for SEO, developed suggestions and explained the relationship between SEO and marketing. They also stated that Google shares 92.78% in the global market and 89.63% in the Turkish market. Google publishes guidelines for SEO optimizations (Google, 2021).

Quality and curricular content will help users spend more time on the website with a well-designed design. While the lack of content suitable for the curriculum cannot meet the user's demand, a well-designed website cannot present the information in the content and may cause loss of users. In addition to an excellent educational website

design, up-to-date and quality content and SEO optimizations will be higher in searches and meet with target users.

## REFERENCES


Abdullah, M.H. (1998). Guidelines For Evaluating Web Sites. ERIC Digest, Thıs Dıgest Was Created By ERIC, The Educatıonal Resources Informatıon Center, ERIC Clearinghouse on Reading English and Communication Bloomington IN. (ERIC Document Reproduction

Abu Shawar, B. (2015). Evaluating web accessibility of educational websites. International Journal of Emerging Technologies in Learning (IJET), 10(4), 4. https://doi.org/10.3991/ijet.v10i4.4518

Allahverdi N. (2002). Uzman Sistemler Bir Yapay Zeka Uygulaması, Atlas Yayın Dağıtım, stanbul.

Alexa. (2020). Top Sites by Category has been retired. (2020, September 21). Alexa. https://support.alexa.com/hc/en-us/articles/360051913314

Altaş, İ. H. (1999). Bulanık Mantık: Bulanıklılık Kavramı. Enerji, Elektrik, Elektromekanik-3e, 62, 80-85.

Awasthi, A., Chauhan, S. S., & Omrani, H. (2011). Application of fuzzy TOPSIS in evaluating sustainable transportation systems. Expert Systems with Applications, 38(10), 12270-12280. doi:10.1016/j.eswa.2011.04.005

Aytaç Adalı, E , Tuş Işık, A . (2017). BİR TEDARİKÇİ SEÇİM PROBLEMİ İÇİN SWARA VE WASPAS YÖNTEMLERİNE DAYANAN KARAR VERME YAKLAŞIMI . International Review of Economics and Management , 5 (4) , 56-77 . DOI: 10.18825/iremjournal.335408

Bozkurt, A. (2020). Koronavirüs (Covid-19) pandemi süreci ve pandemi sonrası dünyada eğitime yönelik değerlendirmeler: Yeni normal ve yeni eğitim paradigması. Açıköğretim Uygulamaları ve Araştırmaları Dergisi, 6(3), 112-142.

Bozkurt, A., Jung, I., Xiao, J., Vladimirschi, V., Schuwer, R., Egorov, G., Paskevicius, M. (2020). A global outlook to the interruption of education due to COVID-19 Pandemic: Navigating in a time of uncertainty and crisis. Asian Journal of Distance Education, 15(1), 1-–126. https://doi.org/10.5281/zenodo.3878572

Bruin, Y. B., Lequarre, A., Mccourt, J., Clevestig, P., Pigazzani, F., Jeddi, M. Z., Goulart, M. (2020). Initial impacts of global risk mitigation measures taken during the combatting of the COVID-19 pandemic. Safety Science, 128, 104773. doi:10.1016/j.ssci.2020.104773

Büyüközkan, G., Arsenyan, J., & Ertek, G. (2010). Evaluation of e-learning web sites using fuzzy axiomatic design based approach. International Journal of Computational Intelligence Systems, 3(1), 28-42.

Büyüközkan, G., Ruan, D., & Feyzioğlu, O. (2007). Evaluating e-learning web site quality in a fuzzy environment. International Journal of Intelligent Systems, 22(5), 567-586.

Carlsson, C., & Fullér, R. (1996). Fuzzy multiple criteria decision making: Recent developments. Fuzzy Sets and Systems, 78(2), 139-153. doi:10.1016/0165-0114(95)00165-4

Cebi, S. (2013). Determining importance degrees of website design parameters based on interactions and types of websites. Decision Support Systems, 54(2), 1030-1043. doi:10.1016/j.dss.2012.10.036

Chang, D.Y., 1996. Applications of the Extent Analysis Method on Fuzzy AHP. European Journal of Operational Research, 95(3), 649-655.

Cuban, L. (1986). Teachers and machines: The classroom use of technology since 1920. New York: Teachers College Press.

Çiçek, İ , Tanhan, A , Tanrıverdi, S . (2020). COVID-19 VE EĞİTİM . Milli Eğitim Dergisi , SALGIN SÜRECİNDE TÜRKİYE'DE VE DÜNYADA EĞİTİM , 1091-1104 . DOI: 10.37669/milliegitim.787736

ÇİTLİ, N. (2006). BULANIK ÇOK KRİTERLİ KARAR VERME. BULANIK ÇOK KRİTERLİ KARAR VERME.Yayınlanan. http://dspace.yildiz.edu.tr/xmlui/bitstream/handle/1/9313/0023829.pdf?sequence=1&isAllowed=y

Dani, D., & Agrawal, G. (2018). Evaluating the Quality of Indian School Education boards' websites using multi criteria decision making models. International Journal of Information Technology, 1-9.

Deb, K., Banerjee, S., Chatterjee, R., Das, A., & Bag, R. (2019). Educational Website Ranking Using Fuzzy Logic and K-Means Clustering Based Hybrid Method. Ingénierie Des Systèmes D Information, 24(5), 497-506. doi:10.18280/isi.240506

Eleren, A. (2007). KURULUŞ YERİ SEÇİMİNİN FUZZY TOPSIS YÖNTEMİ İLE BELİRLENMESİ: DERİ SEKTÖRÜ ÖRNEĞİ. Akdeniz İİBF Dergisi, 07 (13) , 280-295 . Retrieved from https://dergipark.org.tr/en/pub/auiibfd/issue/32315/359096

Elshair, H. M. (2002). The strategies used by students to read educational websites and their relation to website usability and text design (Order No. 3054275). Available from ProQuest Dissertations & Theses Global. (305533484). Retrieved from

https://www.proquest.com/dissertations-theses/strategies-used-students-read-educational/docview/305533484/se-2?accountid=16693

Eristi, S. D., Sahin-Izmirli, O., Izmirli, S., & Firat, M. (2010). An evaluation of educational Web-sites from the perspective of perception-oriented design principles. INSTRUCTIONAL TECHNOLOGY, 3.

Fiş Erümit, S. (2021). The distance education process in K–12 schools during the pandemic period: evaluation of implementations in Turkey from the student perspective, Technology, Pedagogy and Education, 30:1, 75-94, DOI: 10.1080/1475939X.2020.1856178

Garg, R & Jain, D. (2017). Prioritizing e-learning websites evaluation and selection criteria using fuzzy set theory.Management Science Letters, 7(4), 177-184. DOI: 10.5267/j.msl.2017.1.002

Garg, R., Kumar, R., & Garg, S. (2018). MADM-Based Parametric Selection and Ranking of E-Learning Websites Using Fuzzy COPRAS. IEEE Transactions on Education, 1-8. doi:10.1109/te.2018.2814611

Genel Koronavirüs Tablosu. (2020). T.C. Sağlık Bakanlığı COVID-19 Bilgilendirme Platformu. https://covid19.saglik.gov.tr/TR-66935/genel-koronavirus-tablosu.html

Gong, J., Liu, H., You, X., & Yin, L. (2021). An integrated multi-criteria decision making approach with linguistic hesitant fuzzy sets for E-learning website evaluation and selection. Applied Soft Computing, 102, 107118. doi:10.1016/j.asoc.2021.107118

Google, (2021). Arama Motoru Optimizasyonu (SEO) Başlangıç Kılavuzu, https://developers.google.com/search/docs/beginner/seo-starter-guide?hl=tr (Erişim tarihi: 10 Ağustos 2021).

Hasan, L. (2014). Evaluating the Usability of Educational Websites Based on Students' Preferences of Design Characteristics. Int. Arab. J. e Technol., 3(3), 179-193.

Hasan, L., & Abuelrub, E. (2008). Assessing the Quality of Web Sites. INFOCOMP Journal of Computer Science, 7(4), 11-20. Retrieved from http://infocomp.dcc.ufla.br/index.php/infocomp/article/view/234

Hwang, G., Huang, T. C., & Tseng, J. C. (2004). A group-decision approach for evaluating educational web sites. Computers & Education, 42(1), 65-86. doi:10.1016/s0360-1315(03)00065-4

Henkoğlu, H, Mıhcı, P. (2012). Eğitsel İçerikli Web Sitelerinin Kullanımını Etkileyen Faktörler: Ölçek Geliştirme Çalışması. Ege Eğitim Dergisi, 13 (1), 25-39. Retrieved from https://dergipark.org.tr/tr/pub/egeefd/issue/4904/67212

Hsieh, T.-Y., Lu, S.-T., & Tzeng, G.-H. (2004). Fuzzy MCDM approach for planning and design tenders selection in public office buildings. International Journal of Project Management, 22(7), 573–584. doi:10.1016/j.ijproman.2004.01.002

Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2020). The difference between emergency remote teaching and online learning. Educause Review. https://er.educause.edu/articles/2020/3/thedifference-between-emergency-remoteteaching-and-online-learning

Huang, T. C., & Huang, C. (2010). An integrated decision model for evaluating educational web sites from the fuzzy subjective and objective perspectives. Computers & Education, 55(2), 616-629. doi:10.1016/j.compedu.2010.02.022

Jain, D., Garg, R., Bansal, A., & Saini, K. K. (2016). Selection and ranking of E-learning websites using weighted distance-based approximation. Journal of Computers in Education, 3(2), 193-207.

Karakaşoğlu, N. (2008). Bulanık Çok Kriterli Karar Verme Yöntemleri ve Uygulama. Denizli: Pamukkale Üniversitesi Sosyal Bilimler Enstitüsü.

Keršuliene, V., Zavadskas, E. K., Turskis, Z. 2010. Selection of Rational Dispute Resolution Method by Applying New Step-Wise Weight Assessment Ratio Analysis (Swara). Journal of Business Economics and Management, 11(2), 243– 258.

Keskinkılıç, F., & Karataş, S., (2011). Eğitsel İçerikli Web Sitelerinin Metin Tasarım Unsurları Açısından İncelenmesi. Eğitim Teknolojileri Araştırmaları Dergisi, vol.2, no.1, 1-13.

Klir, J. ve Yuan, B. (1995). Fuzzy sets and fuzzy logic theory and applications. New Jersey: Prentice Hall.

Koç Ustalı, N, Tosun, N. (2019). Bulanık AHP ve Bulanık WASPAS Yöntemleri ile Yeni Ürün Seçimi. Pazarlama İçgörüsü Üzerine Çalışmalar, 3 (2), 25-34. Retrieved from https://dergipark.org.tr/en/pub/somi/issue/51997/650875

Köksalan, M., Wallenius, J. and Zionts, S. (2013), An Early History of Multiple Criteria Decision Making. J. Multi-Crit. Decis. Anal., 20: 87-94. https://doi.org/10.1002/mcda.1481

Lee, D. M., Kim, S. Y., Moon, B. Y., & Kang, G. J. (2013). Layout design optimization of pipe system in ship engine room for space efficiency. 한국마린엔지니어링학회지, 37(7), 784-791.

Lin, H. F. (2010). An application of fuzzy AHP for evaluating course website quality. Computers & Education, 54(4), 877-888.

Mardani, A., Jusoh, A., Nor, K. M., Khalifah, Z., Zakwan, N., & Valipour, A. (2015). Multiple criteria decision-making techniques and their applications – a review of the literature from 2000 to 2014. Economic Research-Ekonomska Istraživanja, 28(1), 516-571. doi:10.1080/1331677x.2015.1075139

Mavi, R.K., Goh, M. & Zarbakhshnia, N. Sustainable third-party reverse logistic provider selection with fuzzy SWARA and fuzzy MOORA in plastic industry. Int J Adv Manuf Technol 91, 2401–2418 (2017). https://doi.org/10.1007/s00170-016-9880-x

Millî Eğitim Bakanlığı. (2020). Bakan Selçuk, 23 Mart'ta başlayacak uzaktan eğitime ilişkin detayları anlattı. https://www.meb.gov.tr/bakan-selcuk-23-martta-baslayacak-uzaktanegitime-iliskin-detaylari-anlatti/haber/20554/tr

Nagpal, R., Mehrotra, D., Bhatia, P. K., & Bhatia, A. (2015). FAHP approach to rank educational websites on usability. International Journal of Computing and Digital Systems, 4(04).

Ng, W. S. (2014). Critical design factors of developing a high-quality educational website: Perspectives of pre-service teachers.

Nilashi, M., & Janahmadi, N. (2012). Assessing and prioritizing affecting factors in e-learning websites using AHP method and fuzzy approach. Inform. Knowl. Manage, 2(1).

OECD (2019), OECD Skills Outlook 2019: Thriving in a Digital World, OECD Publishing, Paris, https://dx.doi.org/10.1787/df80bc12-en

OECD (2020). Strengthening online learning when schools are closed: The role of families and teachers in supporting students during the COVID-19 crisis. OECD Policy Responses to Coronavirus (COVID-19). doi:10.1787/c4ecba6c-en

Onyema, E. M., Eucheria, N. C., Obafemi, F. A., Sen, S., Atonye, F. G., Sharma, A., & Alsayed, A. O. (2020). Impact of Coronavirus pandemic on education. Journal of Education and Practice, 11(13), 108-121.

Özer, M. (2020). Educational Policy Actions by the Ministry of National Education in the times of COVID-19 Pandemic in Turkey. Kastamonu Eğitim Dergisi, 28 (3) , 1124-1129 . DOI: 10.24106/kefdergi.722280

Sari, T., & Nayır, F. (2020). Challenges in Distance Education During the (Covid-19) Pandemic Period. Qualitative Research in Education, 9(3), 328–360. https://doi.org/10.17583/qre.2020.5872

Sun, C.-C. (2010). A performance evaluation model by integrating fuzzy AHP and fuzzy TOPSIS methods. Expert Systems with Applications, 37(12), 7745–7754. https://doi.org/10.1016/j.eswa.2010.04.066

Şahin, S. (2017). Çok kriterli karar verme yöntemleri ile bulanık ortamda afet yönetimi sisteminde geçici barınma alanları yer seçimi (Master's thesis, İstanbul Ticaret Üniversitesi).

Şengül, D, Cagıl, G. (2020). Bulanık SWARA ve Bulanık Analitik Hiyerarşi Prosesi Yöntemi ile İş Değerlemesi. Dicle Üniversitesi Mühendislik Fakültesi Mühendislik Dergisi, 11 (3), 965-976. DOI: 10.24012/dumf.715363

ŞENGÜN, A., & TEKTAŞ, M. (2020). PORTFÖY ANALİZİNİN BULANIK MANTIK MODELİYLE BELİRLENMESİ.

Tarafdar, M., & Zhang, J. (. (2005). Analyzing the influence of web site design parameters on web site usability. Information Resources Management Journal, 18(4), 62-80. doi:10.4018/irmj.2005100104

Tarafdar, M., & Zhang, J. (2008). Determinants of reach and loyalty—A study of website performance and implications for website design. Journal of Computer Information Systems, 48(2), 16-24.

TELLİ, E., & SELİM, Y. (2009, May). BÖTE ÖĞRENCİLERİNİN TERCİH AŞAMASINDAKİ ve SONRASINDAKİ MESLEKİ BEKLENTİLERİNİN BELİRLENMESİ AN INVESTIGATION OF PROFESSIONAL EXPECTATIONS OF CEIT STUDENTS BEFORE AND AFTER SELECTING MAJOR. In PROCEEDINGS of 9 th INTERNATIONAL EDUCATIONAL TECHNOLOGY CONFERENCE.

Tractinsky, N., Cokhavi, A., & Kirschenbaum, M. (2004). Using ratings and response latencies to evaluate the consistency of immediate aesthetic perceptions of web pages. SIGHCI 2004 Proceedings, 13.

Toklu, M.C., Bozkurt, İ. and Sekmen, B., (2020). "Bulanık AHP ve Bulanık WASPAS Yaklaşımı ile Kaizen Öneri Sistemi Değerlendirme Modeli", Academic Platform Journal of Engineering and Science, vol. 8, no. 1, pp. 128-138, doi:10.21541/apjes.579084

Turskis, Z., Zavadskas, E., Antucheviciene, J., & Kosareva, N. (2015). A Hybrid Model Based on Fuzzy AHP and Fuzzy WASPAS for Construction Site Selection. INTERNATIONAL JOURNAL OF COMPUTERS COMMUNICATIONS & CONTROL, 10(6), 113-128. doi:10.15837/ijccc.2015.6.2078

Udjaja, Y., Indrianti, Y., Rashwan, O. A., & Widhoyoko, S. A. (2018, October). Designing website e-learning based on integration of technology enhance learning and human

computer interaction. In 2018 2nd International conference on informatics and computational sciences (ICICoS) (pp. 206-212). IEEE.

UNESCO. (2020). Education: From disruption to recovery . UNESCO. https://en.unesco.org/covid19/educationresponse

UNESCO. (2021a). Global Education Coalition. (2021, August 05). Retrieved from https://en.unesco.org/covid19/educationresponse/globalcoalition

UNESCO. (2021b). EFW: Education finance watch 2021. UNESDOC Digital Library. https://unesdoc.unesco.org/ark:/48223/pf0000375577

UNICEF. (2021, 02 March). COVID-19: Schools for more than 168 million children globally have been completely closed for almost a full year, says UNICEF. https://www.unicef.org/press-releases/schools-more-168-million-children-globally-have-been-completely-closed

Wikipedia. (2021). Türkiye'de COVID-19 pandemisi zaman çizelgesi. Wikipedia. https://tr.wikipedia.org/wiki/T%C3%BCrkiye%27de_COVID-19_pandemisi_zaman_%C3%A7izelgesi

Yaman, B. (2021). Covid-19 Pandemisi Sürecinde Türkiye Ve Çin'de Uzaktan Eğitim Süreç Ve Uygulamalarının İncelenmesi. OPUS Uluslararası Toplum Araştırmaları Dergisi, Pandemi Special Issue, 3298-3308. DOI: 10.26466/opus.857131

Yeh, C., & Deng, H. (2004). A practical approach to fuzzy utilities comparison in fuzzy multicriteria analysis. International Journal of Approximate Reasoning, 35(2), 179-194. doi:10.1016/j.ijar.2003.09.002

Yiğit, N., Altun, T., Alev, N., Dertlioğlu, K., & Bülbül, M. Ş. (2007). Öğretim Amaçlı Web Sitelerinin Değerlendirilmesine Yönelik Bir Ölçek Tasarımı, 1. Ulusal İlköğretim Kongresi, 15-17 Kasım.

Yurdanur, A., Çini, Ö., & Doğan, M. (2007). Web Tabanlı Uzaktan Eğitimde Tasarım Öğelerinin Öğrenme Üzerindeki Etkileri ve Öğrenci Tercihleri. Akademik Bilişim.

Yüksel, D, Tolon, M. (2019). DİJİTAL PAZARLAMA STRATEJİSİ OLARAK ARAMA MOTORU OPTİMİZASYONU (SEO). . International Journal of 3D Printing Technologies and Digital Industry, 3 (3), 236-243. Retrieved from https://dergipark.org.tr/en/pub/ij3dptdi/issue/51591/651386

Zadeh, L. (1965). Fuzzy sets. Information and Control, 8(3), 338-353. doi:10.1016/s0019-9958(65)90241-x

Zadeh, L. A. (1973). Outline of a New Approach to the Analysis of Complex Systems and Decision Processes. IEEE Transactions on Systems, Man, and Cybernetics, SMC-3(1), 28-44. doi:10.1109/tsmc.1973.5408575

Zadeh, L. (1975). The concept of a linguistic variable and its application to approximate reasoning—I. Information Sciences, 8(3), 199-249. doi:10.1016/0020-0255(75)90036-5

Zavadskas, E. K., Turskis, Z., Antucheviciene, J., & Zakarevicius, A. (2012). Optimization of Weighted Aggregated Sum Product Assessment. Elektronika Ir Elektrotechnika, 122(6), 3-6. https://doi.org/10.5755/j01.eee.122.6.1810

Zu, Z. Y., Jiang, M. D., Xu, P. P., Chen, W., Ni, Q. Q., Lu, G. M., & Zhang, L. J. (2020). Coronavirus disease 2019 (COVID-19): a perspective from China. Radiology,

**APPENDIX 1: The Evaluated Websites**

1- Khan Academy

2- Evvel Cevap

3- Matematikçiler

4- Ders Çalışıyorum

5- Biyoloji Portalı

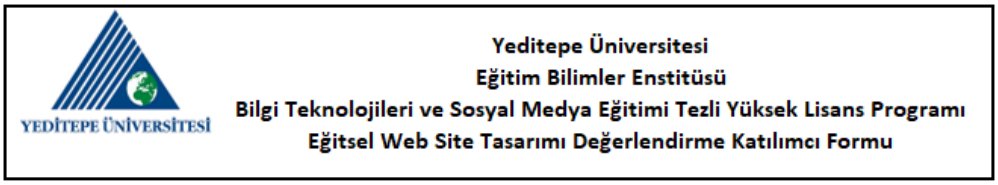
6- Dersimis

7- Selin Hoca

8- Fen Bilimleri

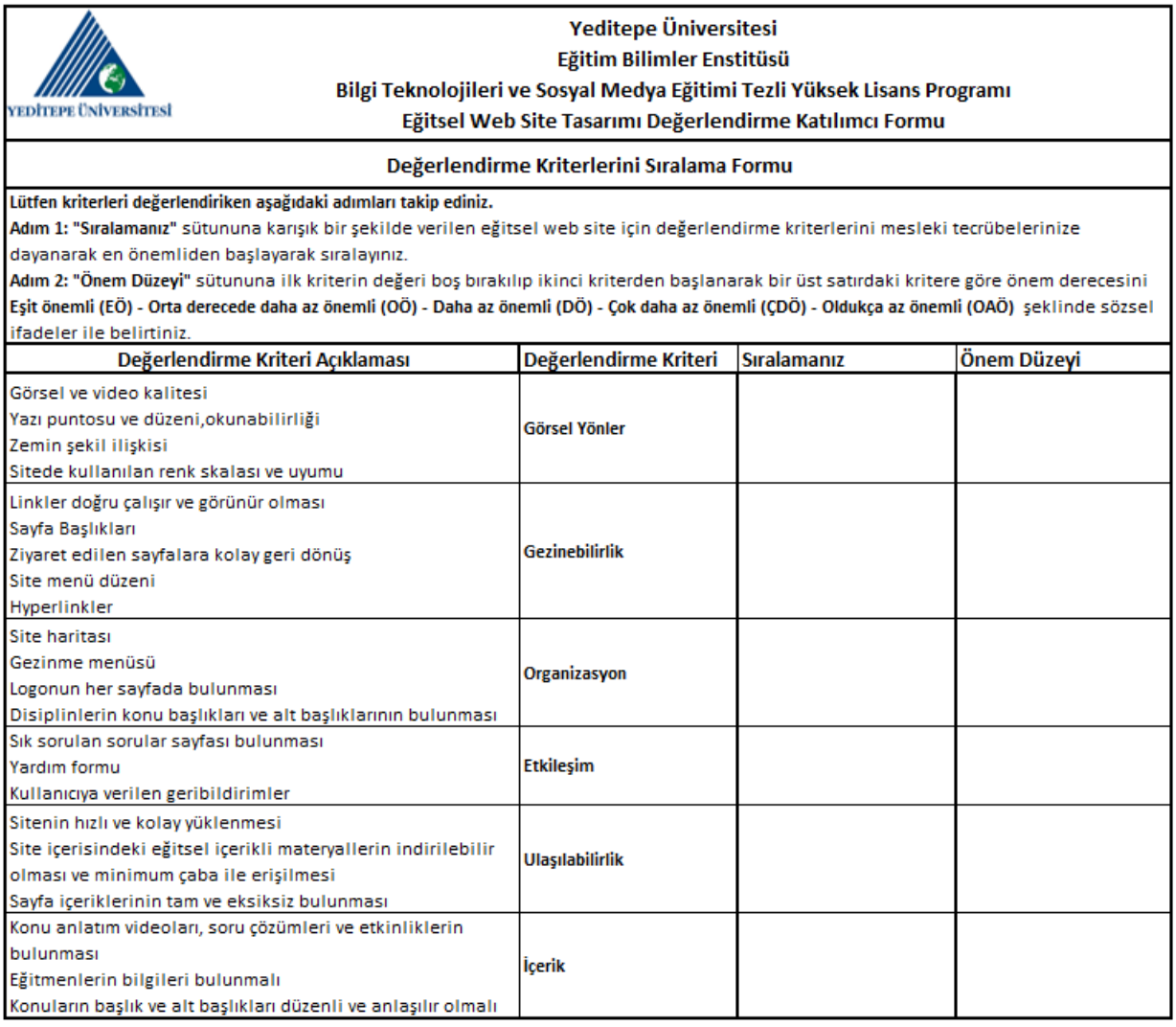
## APPENDIX 2: The Data Collection Instruments From Participants

### The form used to get the Information of the Participating Experts




| Katılımcının Demografik Özellikleri | |
|---|---|
| Adınız Soyadınız: | |
| Yaşınız: | |
| Mesleğiniz: | |
| Mesleki Tecrübeniz: | |
| Cinsiyetiniz: | |

### The Form Experts Use to Evaluate the Criteria



## The Form Used by Experts to Evaluate Educational Websites

**Yeditepe Üniversitesi**
**Eğitim Bilimler Enstitüsü**
**Bilgi Teknolojileri ve Sosyal Medya Eğitimi Tezli Yüksek Lisans Programı**
**Eğitsel Web Site Tasarımı Değerlendirme Katılımcı Formu**

Lütfen aşağıdaki linkleri verilen eğitsel web sitelerini değerlendirme kriterlerine göre inceledikten sonra her web site için değerlendirmelerinizi belirlenen alanlara **(1)Çok Düşük (ÇD) - (2)Düşük (D) - (3)Orta (O) - (4)Yüksek (Y) - (5)Çok Yüksek (ÇY)** şeklinde sözsel ifadeler ile belirtiniz.

**Eğitsel Web Site Değerlendirme Formu**

| Eğitsel Web Site Linki | Site Adı | Değerlendirme Kriterleri | | | | | |
|---|---|---|---|---|---|---|---|
| | | Görsel Yönler | Gezinebilirlik | Organizasyon | Etkileşim | Ulaşılabilirlik | İçerik |
| http://www.khanacademy.org.tr/ | Khan Academy | | | | | | |
| https://www.evvelcevap.com/ | Evvel Cevap | | | | | | |
| https://www.matematikciler.com/ | Matematikçiler | | | | | | |
| https://www.derscalisiyorum.com.tr/ | Ders Çalışıyorum | | | | | | |
| http://biyolojiportali.com/ | Biyoloji Portalı | | | | | | |
| https://dersimis.com/ | Dersimis | | | | | | |
| https://www.selinhoca.com/ | Selin Hoca | | | | | | |
| https://fenbilimleri.org/ | Fen Bilimleri | | | | | | |

## APPENDIX 3: The Educational Website Evaluation Data of Experts

| | | **C1** | **C2** | **C3** | **C4** | **C5** | **C6** |
|---|---|---|---|---|---|---|---|
| E1 | W1 | P | G | F | P | F | G |
| | W2 | G | G | F | G | VP | P |
| | W3 | G | G | P | F | F | F |
| | W4 | P | F | G | F | F | F |
| | W5 | VP | F | F | F | F | G |
| | W6 | VP | F | F | VP | F | VP |
| | W7 | P | P | P | VP | P | P |
| | W8 | G | F | F | F | F | F |
| E2 | W1 | F | G | G | VP | G | VG |
| | W2 | VP | F | F | VP | F | VP |
| | W3 | VP | G | VP | VP | P | VP |
| | W4 | VP | G | P | VG | F | VG |
| | W5 | VP | F | P | VP | P | F |
| | W6 | VG | VG | G | VG | G | VG |
| | W7 | VP | P | F | P | P | P |
| | W8 | VP | P | P | VP | VP | G |
| E3 | W1 | VG | G | G | F | VG | G |
| | W2 | G | F | P | F | P | F |
| | W3 | G | F | F | F | F | F |
| | W4 | F | P | P | F | F | P |
| | W5 | P | F | G | F | F | F |
| | W6 | F | P | F | P | F | F |
| | W7 | F | F | G | P | F | F |
| | W8 | G | F | P | F | F | F |
| E4 | W1 | VG | F | F | P | F | G |
| | W2 | F | G | G | F | F | G |
| | W3 | G | G | F | F | F | G |
| | W4 | P | F | F | F | G | G |
| | W5 | P | P | F | P | F | F |
| | W6 | P | F | F | F | P | F |
| | W7 | P | P | P | P | F | F |
| | W8 | G | F | G | G | G | G |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| E5 | W1 | VG | G | G | G | G | G |
| | W2 | F | VG | VG | G | G | VG |
| | W3 | VG | VG | VG | VG | VG | VG |
| | W4 | P | F | F | F | G | G |
| | W5 | F | P | F | F | F | F |
| | W6 | P | F | F | F | P | F |
| | W7 | P | P | P | P | F | F |
| | W8 | VG | VG | VG | G | VG | G |
| E6 | W1 | G | G | G | G | G | G |
| | W2 | G | VG | VG | G | G | VG |
| | W3 | VG | VG | VG | VG | VG | VG |
| | W4 | F | F | F | F | G | G |
| | W5 | F | F | F | F | F | F |
| | W6 | P | F | F | F | P | F |
| | W7 | P | P | P | P | F | P |
| | W8 | VG | VG | G | G | VG | G |