Journal of Teaching Language Skills
(JTLS)
40(1), Winter 2021, pp. 153-186
DOI: 10.22099/jtls.2021.39802.2926

Online ISSN: 2717-1604
Print ISSN: 2008-8191

Research Paper

A Fuzzy TOPSIS Approach to Ranking the Effectiveness of Corrective Feedback Strategies: Monolingual Persian Versus Bilingual Turkmen EFL Learners

Maryam Moazzeni Limoudehi [*] **Omid Mazandarani** [**]

Department of English Language Teaching, Aliabad Katoul Branch, Islamic Azad University, Aliabad Katoul, Iran

Behzad Ghonsooly [***]
Ferdowsi University of Mashhad

Jila Naeini [****]

Department of English Language Teaching, Aliabad Katoul Branch, Islamic Azad University, Aliabad Katoul, Iran

Abstract

Corrective feedback (CF) as a multifaceted practice needs to be explored from different perspectives. Achieving relative consensus among language teachers and experts in a particular context on the most effective CF strategy for monolingual and bilingual language learners appears to be understudied. As such, a fuzzy TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) model was applied to accommodate varied and conflicting opinions in ranking the effect of three corrective feedback strategies including mid-focused oral metalinguistic CF, written metalinguistic CF, and oral/written metalinguistic CF. To this end, 79 monolingual Persians and 79 bilingual Turkmens aged between 13

Received: 28/12/2020 Accepted: 14/02/2021

[*] PhD candidate, Email: moazzenim@yahoo.com
[**] Assistant Professor, Email: omazandarani@gmail.com, Corresponding Author
[***] Professor, Email: ghonsooly@um.ac.ir
[****] Assistant Professor, Email: naeini.j@gmail.com

and 18 from two language institutes in Golestan Province of Iran participated in the study comprising three experimental and one control group each. The experimental groups were provided with CF strategies on their most recurrent grammatical errors detected through pretests while the control groups received none. The results of the fuzzy TOPSIS approach ranked oral/written metalinguistic CF and oral metalinguistic CF as the best strategies for monolingual Persians and bilingual Turkmens respectively. The fuzzy TOPSIS approach provided experts with the opportunity to include their opinions on the weight of criteria and the impact of CF strategies towards enhancing the experts' agreement on the issue. It was shown that a single CF strategy might not be appropriate for all EFL learners in different contexts. The approach also provided a framework for soliciting wider participation of the experts when conditions favor the application of multi-criteria decision-making methods, or speedier assessments are required.

Keywords: Bilingual Turkmens, EFL writing, Fuzzy TOPSIS, Grammatical Errors, Metalinguistic Corrective feedback

When an error occurs, the next step would be how to react to that specific error. This refers to the important issue of corrective feedback (CF) as an inherent and vital part of any educational program including teaching writing to EFL/ESL learners. Corrective feedback has an important role in L2 teaching and many studies (e.g., Ahmadian, Mehri, & Ghaslani, 2019; Amin & Saadatmanesh, 2018; Eslami & Derakhshan, 2020; Hosseini Bay & Dehghan, 2019; Karim & Nassaji, 2019; Nassaji, 2017; Rezaei & Derakhshan, 2011) have shown its vital role in the writing process. Since errors in writing are documented, providing CF becomes utterly important as errors might make learners' writing less fluent and cohesive. Corrective feedback can raise learners' explicit knowledge as they pay more attention to what they write (Carless, 2006). In the same vein, teachers can support their learners in finding out which parts of their writing need improvement, and learners will have a better understanding of their performance accordingly. L2 Learners can be

provided with direct, indirect, and metalinguistic CF strategies. Oral metalinguistic corrective feedback (OMCF), written metalinguistic corrective feedback (WMCF), and integration of the two former strategies (OWMCF) are different types of metalinguistic CF.

Theorists and instructors have long been in search of the best and the most effective way to treat learners' errors (Ferris, 2010) as there are myriads of mediating factors that might exert influence on the efficacy of CF (Eslami & Derakhshan, 2020). Despite all the research, there is still controversy among theorists and EFL/ESL teachers on the topic. The followings seem to be some general issues in need of further exploration in the field of CF: The way CF should be provided, strategies that should be employed (Eslami & Derakhshan, 2020), the best choice of CF strategy for monolingual and bilingual EFL learners, and how the EFL/ESL teachers can achieve relative consensus regarding the choices made. These issues can be approached through multi-criteria decision-making methods (MCDM).

Multi-criteria decision-making methods can help in determining the best alternative among many candidates considering several weighted criteria. Examples are choosing the best supplier and purchasing the best house/car on the basis of different factors such as price, style, and constructor. Of the famous MCDM methods, Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) has found wide usage in recent years partly due to its relative simplicity and vigor in its bases. Developed by Hwang and Yoon (1981), TOPSIS is used to find the relative closeness of several alternatives to the ideal solution using a decision matrix comprised of weighted criteria in columns and alternatives in rows. It is an analytical method that takes into account multiple alternatives with multiple criteria and assists in making informed decisions when dealing with multiple choices. Choosing the best CF

strategy under the impact of various weighted criteria generates another situation for employing MCDM methods such as TOPSIS that is the focus of the present research.

Likewise, there is the problem of subjectivity of human judgments, insufficiency, and unreliability of data, and also measurement errors in gathering data for multiple alternatives based on multiple criteria (Pedrycz, Ekel, & Parreiras, 2011). There may be disagreement among experts on the choice of criteria for a problem, the best method(s) to measure the criteria, and their preferred weights. Despite a profusion of research in the field of corrective feedback, it appears the search continues for a CF strategy as a panacea for EFL/ESL learners with dissimilar L1(s) in different contexts since L2 development is a dynamic, non-linear, and disorganized activity (Schulze & Smith, 2015). In such cases, applying a rigid Boolean logic (zero & one) may lead to biased conclusions or disagreements. Therefore, reference is made to fuzzy logic to accommodate such uncertainties, measurement errors, and disagreements. The fuzzy logic has obtained propulsion in numerous scientific fields because of its capability to display effective answers to real-life complications.

A bilingual or multilingual English class challenges the teacher as well as the learner as there are several languages other than English on the continuum of language learning that may interfere in the process of language teaching and learning. Bilingual/multilingual learners are likely to use their L1(s) intuitively through their own fuzzy rules (Sinha, 2017). In addition, there are myriads of internal and external mediating factors such as learners' L1(s) that can play roles in the success, or failure of CF strategies (Bitchener & Storch, 2016). Karim and Nassaji (2019) called for research on the possible influence of the mediating variables on the effectiveness of CF strategies as

these variables might have caused controversial results in the field and failure in some former studies. These questions still remain in the practice of CF: "How can an EFL/ESL teacher decide on the best and the most effective CF to treat learners' errors considering the time constraint in the classes and the fuzziness of the situation?" "Do learners with diverse goals, motivations, and different prior L1(s) benefit from CF equally (Bitchener & Ferris, 2012)?" Most studies substantially reported positive role of the fuzzy logic in general and the fuzzy TOPSIS in particular in ranking and overcoming the contradictory views (e.g., Du, 2018; Ivanova & Zlatanov, 2019; Liu, 2015; Moayeri, Shahvarani, Behzadi, & Hosseinzadeh-Lotfi, 2015; Shahballa & Alamdar Youli, 2012; Shahballa, Ghonsooly, & Karami, 2019). To date, limited considerations have been given to the effectiveness rank of various strategies of corrective feedback using the fuzzy TOPSIS among monolingual and bilingual language learners in general and monolingual Persian and bilingual Turkmen EFL learners in particular.

Literature Review

Corrective Feedback

Over the past two decades, there have been several shifts in the trend of teaching L2 writing, and teachers' and theorists' views of the importance of grammar, error correction, and accuracy were not excluded. Behaviorists viewed errors as harmful to the learning process and treated learners' every single error immediately to avoid the formation of bad habits (Ferris, 2011). Conversely, nativists contended that corrective feedback barely had any role in the acquisition process. However, interactionists viewed errors as treatable through naturally occurring corrective feedback during the interaction. Later, the attention was given to the process approach (Ferris, 2011), where

grammatical errors were overlooked and considered to be unfair to the learners (Ferris, 1995).

Corrective feedback was referred to as an answer to the learner's inaccurate production (Nassaji & Kartchava, 2017). Despite being a vital component of L2 writing, the literature has not indisputably advocated CF (Hyland & Hyland, 2006). The usefulness of CF was challenged (Bitchener, 2008) when Truscott (1996, p.327) claimed that written CF was "ineffective, harmful, and should be abandoned." Ferris (1999) and Chandler (2003) challenged Truscott's claim that led to a surge of studies on CF and its effectiveness in L2 writing.

To correct the EFL/ESL learners' linguistic errors, the teachers can provide learners with the accurate forms of their faulty structures, repeat statements and substitute the faulty parts with the correct forms, ask for clarification and modification, restate the faulty structures with/without emphasizing the incorrect form, and apply metalinguistic CF. The metalinguistic CF comprises questions, information, or comments germane to the accuracy of the learner's production devoid of explicit correct forms (Lyster & Ranta, 1997). Corrective feedback strategies can also be differentiated based on their extent of focus. All the errors are the focus of the treatment in unfocused CF while the teacher targets some error categories in focused CF (Ellis, 2009), and only one error category is treated in highly focused CF (Bitchener & Knoch, 2009). Last but not least, the mid-focused CF concentrates on two to six grammatical structures (Liu & Brown, 2015). Another aspect for the classification of the corrective feedback strategies is whether they are administered orally, or in written form (Karim & Nassaji, 2019).

Fuzzy Logic

The fuzzy theory, established by Zadeh (1965), plays a significantly positive role in overcoming the contradictory opinions, errors of measurement, and other imprecisions (Cohen, Manion, & Morrison, 2018; Pedrycz, et al., 2011). Since 1965, scholars have been engrossed with fuzzy logic for decision-making purposes (e.g., Nădăban, Dzitac, & Dzitac, 2016). According to Zadeh (2008, p. 2751), "fuzzy logic is a precise logic of imprecision and approximate reasoning." Some scholars state that the notion of the linguistic variable in fuzzy logic gives the researchers the luxury of computation with words instead of numbers making it extremely practical in decision-making problems (Nădăban et al., 2016 & Sinha, 2017).

Much attention has been given to the fuzzy TOPSIS as one of the MCDM methods in diverse areas such as computer science, philosophy, and linguistics in recent years (Sobrino, 2013). Through the application of this method, decision-makers (DMs), or experts in a field can use values such as "middle", "high", and "low" instead of classical variables as "yes/no", "true/false", and "0/1".

The prime dissimilarities between classical logic and fuzzy logic are displayed in Table 1 (Sahin, Leung Yip, Tseng, Kabak, & Soylu, 2020).

Table 1.

Main Differences of the Classical and Fuzzy Logic (Adopted from Sahin et al., 2020, p.4)

Classical Logic	**Fuzzy Logic**
A or not A	A and not A
Certain	Partial
All or none	Particular degrees
0 or 1	Between 0 and 1 continuity
Double units	Fuzzy units

Empirical Studies

Bitchener and Knoch (2008) provided the learners with direct CF plus written and oral metalinguistic explanation, direct CF plus written metalinguistic explanation, and direct CF only. The first experimental group outperformed the others. Similarly, Bitchener and Knoch (2009) examined the effect of direct CF plus written and oral metalinguistic explanation, direct CF plus written metalinguistic explanation, and direct CF only on English articles "a" and "the". The treatment groups performed better than the control group. Besides, Bitchener and Knoch (2010) studied the effect of written metalinguistic explanation, indirect CF, and oral metalinguistic CF; the treatment groups outdid the control group.

In the Iranian context, Shafiee Sarvestani and Pishkar (2016) reported direct CF to be more effective while Sadat, Zarifi, Sadat, and Malekzadeh (2015) found indirect CF to be superior. In contrast, Amin and Saadatmanesh (2018) did not report any significant difference between the two CF strategies. Pertinent to metalinguistic CF, Rezaei, and Derakhshan (2011) indicated that metalinguistic CF was more effective compared to recast. Conversely, Kheradmand Saadi and Saadat (2015) did not report any significant difference between direct and metalinguistic CF with reference to the EFL learners' knowledge of grammar. With regard to focused CF, Ebadi (2014) found improvement in the EFL learners' writing accuracy after receiving focused metalinguistic CF. Moreover, the results of a study by Aghajanloo, Mobini, and Khosravi (2016) showed the effectiveness of focused and unfocused CF on the learners' writing accuracy. Several studies that employed fuzzy logic in education are reviewed hereinafter.

Liu (2015) evaluated foreign language teaching effectiveness through multiple attribute decision making using fuzzy logic. Of the same kind, Du

(2018) successfully investigated the accuracy of English teaching quality evaluation based on fuzzy logic. Wang (2016) improved flipped classroom teaching model using a fuzzy comprehensive evaluation model. Moreover, Sinha (2017) demonstrated that fuzzy-based language pedagogy made the classroom more real by considering L1 interference as a language learning source. Related to language assessment, Ivanova and Zlatanov (2019) used fuzzy logic to revise the test results of 78 students and concluded the usefulness of the approach. Furthermore, Shahballa et al. (2019) developed and validated a new version of an EFL multiple-choice reading comprehension test grounded on fuzzy logic. The outcomes revealed that the method was fairer by considering the partial information of the test takers which was overlooked in traditional multiple-choice tests. In a similar vein, Shahballa and Alamdar Youli (2012) applied fuzzy logic to assess 19 MA students' reading comprehension at Shiraz University and pointed out the fuzzy scores were more unbiased and precise.

Ertuğrul and Karakaşoğlu (2007) used the fuzzy TOPSIS for the selection of academic members and found it beneficial in increasing the quality of education. In addition, Hota, Sharma, and Pavani (2014) applied the fuzzy TOPSIS to rank 10 higher education teachers based on the five criteria with satisfactory results corroborated by the experts. Pavani, Sharma, and Hota (2013) and Khoshi, Gooshki, and Mahmoudi (2018) developed a fuzzy TOPSIS tool for teacher evaluation and prioritization. In the same line, Duc et al. (2019) employed the fuzzy TOPSIS to evaluate lecturers' performance with the capability of representing vague data. Moreover, Al-Hammadi and Milne (2004) developed a fuzzy model for evaluation and prediction of the students' performances before being accepted in college on the basis of their high school exam results and showed only some of the entrance examinations

were fair indicators of the students' levels. Alaa et al. (2019) also presented a fuzzy framework to assess and rank the English skills of 31 Malaysian teaching students whose L1 was not English. Last but not least, Fedrizi and Molinari (2013) applied a multi-expert fuzzy TOPSIS to evaluate e-learning methods.

The effectiveness ranks, or as Bitchener (2008) puts it superiority of a particular CF strategy has yet to be explored in EFL contexts. Despite the wide range of applications of fuzzy logic, the literature did not reveal any document on ranking corrective feedback strategies using fuzzy TOPSIS. Moreover, there is a scarcity of comparative research between monolinguals and bilinguals in general and monolingual Persians and bilingual Turkmens in particular. To narrow the gap, the aim of the present research was set at ranking three corrective feedback strategies; namely mid-focused OMCF, WMCF, and OWMCF through fuzzy TOPSIS. In addition, the objective was also set at exemplifying how to analyze data including a matrix of alternatives' performances with several weighted criteria in a collective manner and to include the varying and conflicting opinions of the experts at the same time. To fulfill the objectives of the research, the following research questions were formulated:

1. What is the effectiveness rank of CF strategies for the most recurrent written grammatical errors of monolingual Persian and bilingual Turkmen EFL learners at an intermediate level using a fuzzy TOPSIS approach?
2. Do monolingual Persian and bilingual Turkmen EFL learners at intermediate level equally benefit from CF strategies employing a fuzzy TOPSIS approach?

Method

Participants and Context of the Study

This quasi-experimental research was carried out at two private English language institutes located in Gorgan and Simin Shahr, Golestan Province, Iran. Almost all the residents are Turkmens in Simin Shahr. Turkmens' first language is Turkmeni, a branch of Turkic language; Persian is their second language making English their third language. A number of 116 monolingual Persians and 79 bilingual Turkmens were available as intermediate EFL learners at the institutes; however, to have equal participants, 79 monolingual Persians' writing samples were randomly selected for further analyses. The total number of participants was 158 (79 L1-Persians & 79 L1-Turkmens) selected based on a convenient non-random sampling method, but randomly assigned into six experimental and two control groups. The participants aged between 13 and 18 and attended English classes twice a week at each language institute. Their other exposure to English was limited to their high school English classes held once a week. Moreover, five academic members of the university as the experts/decision-makers with at least ten years of EFL teaching experience filled out the opinion forms *(*Sahin et al., 2020, p.6).

Instrument

Oxford Placement Test

The participants sat the first version of the Oxford Quick Placement Test (2001) to ensure their intermediate level of proficiency. It is a proficiency test comprising 60 multiple-choice questions for determining participants' level of proficiency and homogeneity (Table 2). The participants were given 30 minutes to take the test. The reliability of the test turned out to be 0.84 using KR-20 formula. The participants also filled out a background information form.

Table 2.
Quick Oxford Placement Test Scores

Score	Language Proficiency Level
1-10	Elementary
11-20	Pre-Intermediate
21-30	Intermediate
31-40	Upper Intermediate
41-60	Advanced

Instructional materials

The instructional materials were chosen according to the EFL learners' most recurring grammatical errors. All the instructional materials were selected from these books: *Oxford Practice Grammar for Intermediate* (Eastwood, 2003) and *Grammar in Use for Intermediate* (Murphy & Smalzer, 2009). The learners also received a list of some of the frequently used regular and irregular English verbs and their past simple tense. Opinion forms were prepared based on the linguistic variables for the criteria and performance priorities adopted from (Sahin et al., 2020, p.6).

Data Collection Procedure

Pretest

In the pretest phase, all the participants wrote 150-200-word scripts on two descriptive subjects (describe your teacher(s), and describe the last movie you watched). The participants were given an hour to write since some studies of this kind (Bitchener, Young, & Cameron, 2005) allocated 45 minutes for 250-word writing tasks of ESL learners. The purpose of the pretest phase was identifying the participants' most frequent written grammatical errors based on a primary source. The results of the pretests based on the framework of the

study (Bitchener et al., 2005) containing 28 grammatical categories revealed the participants' five most frequent grammatical errors in "past simple", "present simple", "preposition", "singular/plural verb", and "indefinite article (a)". Based on the results of some studies (e.g., Al Mubarak, 2017; Bitchener, et al., 2005; Salehi & Bahrami, 2018), the EFL/ESL learners' most frequent grammatical errors occurred in "verb tenses", "past simple tense", "singular/plural verb", "prepositions", and "articles" that were somewhat in line with the that of the present research.

Corrective Feedback Treatments

The first experimental groups (22 Persians/22 Turkmens) received mid-focused OMCF in the form of grammar mini-lessons. In the first treatment session, the "past simple tense" was explained followed by the treatment of the "regular/irregular verbs", the use of "did", and its "time markers". The learners were also provided with relevant examples. In the second session, the function of the "present simple tense", the use of "do/does"," don't/doesn't", the related "time markers", and the "adverbs of frequency" were clarified. Additionally, the correct conjugation of the "to be" verbs plus some verbs in the "present simple tense" were reviewed drawing learners' attention to the third person singular "s". In the third session, the treatment was based on the learners' most problematic "prepositions". The prepositions were categorized for the learners. For instance, the use of "in" for parts of a day such as "in the morning", "in the afternoon", and "in the evening" was mentioned. The focus of the fourth session was the "singular/plural verb". Correct use of the "s" for the third person singular, differentiating between "was/were", "have/has", "do/does", and proper use of singular/plural verbs for certain nouns such as "jeans" were explained to the learners too. The fifth session was about the "indefinite article (a)" in which the error category was elucidated through a

contrastive analysis between Persian and English as well as Turkmeni and English with the assistance of the bilingual Turkmens.

The second experimental groups (18 Persians/18 Turkmens) received the mid-focused WMCF treatment with self-study materials and activities on each of the five recurrent grammatical errors. The participants received handouts prepared based on the grammar books mentioned in section 3.3 each session. In the first treatment session, the "past simple tense" was covered using the handouts containing the grammatical rules and some activities. The participants were asked to self-study the materials silently and undertake the activities. The procedures in the second, third, fourth, and fifth treatment sessions were the same for the other four recurrent grammatical errors. No explanation of the grammatical errors was provided to the learners to keep the class interactions to the minimum.

The third experimental group (19 Persians/19 Turkmens) received the mid-focused OWMCF strategy. The treatment time was distributed between the mid-focused OMCF and WMCF strategies. The procedure of providing the EFL learners with the treatment was exactly similar to those of OMCF and WMCF when conducted separately. It is noteworthy to say that all the treatment sessions lasted 30-40 minutes and were provided by the researcher to control the teacher variable as a possible confounding variable. The control groups did not receive any treatment and their writing samples were marked conventionally.

Posttest

Overall, there were five treatment sessions and a 20-minute review session for each experimental group. Posttests were administered one week after the review sessions. All the participants including the six experimental and the two control groups wrote 150-200-word samples on two new descriptive

subjects (describe your house/apartment, and describe your last vacation). To assure inter-rater reliability, all the 632 writing samples were corrected by the researcher and two other raters based on the framework of the study with 97% similarity in the results. The fuzzy TOPSIS forms adopted from Sahin et al. (2020, p.6) were sent to the experts electronically and collected through the same venue.

Data Analysis

The errors in the posttest stages were subtracted from those of the pretest to reveal the degree of change as a result of the treatments. These values constituted a performance matrix for the CF strategies as the alternatives and the five most recurrent grammatical errors as the criteria. The differences between pretest and posttest phases generated the values of the performance matrix for the fuzzy TOPSIS. In the process, the criteria and performance values were submitted to the experts that assigned trapezoidal linguistic fuzzy weights (Sahin et al., 2020) (Figure 1). After collecting the linguistic fuzzy variables for the criteria and the performances from the experts, these variables were converted into fuzzy values. The membership function of the trapezoidal fuzzy number is defined in Equation 1.

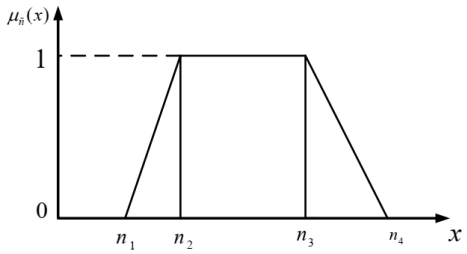

Figure 1.
Trapezoidal Fuzzy Number (Sahin et al., 2020, p.5)

$$\mu_{\tilde{n}}(x) = \begin{cases} 0, & x < n_1 \\ \frac{x-n_1}{n_2-n_1}, & n_1 \le x \le n_2 \\ 1, & n_2 \le x \le n_3 \\ \frac{x-n_4}{n_3-n_4}, & n_3 \le x \le n_4 \\ 0, & x > n_4 \end{cases} \qquad \text{Equation 1}$$

Examples of the linguistic variables for the criteria and performance priorities used in this research are presented in Tables 3 and 4.

Table 3.

Linguistic Variables for Criteria Priorities (Sahin et al., 2020, p.6)

Linguistic Expression	Abbreviation	Trapezoidal Fuzzy Number
Very High	VH	(0.8 0.9 1.0 1.0)
High	H	(0.7 0.8 0.8 0.9)
Middle High	MH	(0.5 0.6 0.7 0.8)
Middle	M	(0.4 0.5 0.5 0.6)
Middle Low	ML	(0.2 0.3 0.4 0.5)
Low	L	(0.0 0.2 0.2 0.3)
Very Low	VL	(0.0 0.0 0.1 0.2)

Table 4.

Linguistic Variables for Performance Priorities (Sahin et al., 2020, p.6)

Linguistic Expression	Abbreviation	Trapezoidal Fuzzy Number
Very Good	VG	(8 9 10 10)
Good	G	(7 8 8 9)
Middle Good	MG	(5 6 7 8)
Fair	F	(4 5 5 6)
Middle Poor	MP	(2 3 4 5)
Poor	P	(0 2 2 3)
Very Poor	VP	(0 0 1 2)

When the experts provided the linguistic variables for the performance priorities, these were converted into the fuzzy values using Equation 2, where a_{ij} denotes minimum of the values of the first column in Table 4. b_{ij} and c_{ij} show averages of the values of the second and third columns for the *k* experts participated in the process, and d_{ij} depicts maximum of the fourth column from the left in Table 4.

$$a_{ij} = \min_k\{a_{ijk}\}, b_{ij} = \frac{1}{K}\sum_{k=1}^{K} b_{ijk}$$
$$c_{ij} = \frac{1}{K}\sum_{k=1}^{K} c_{ijk}, d_{ij} = \max_k\{d_{ijk}\} \qquad \text{Equation 2}$$

For the fuzzy weights, a minimum of the first column, averages of the *k* values selected by the *k* experts for the second and the third columns, and a maximum of the fourth column was derived using Equation 3.

$$w_{j1} = \min_k\{w_{jk1}\}, w_{j2} = \frac{1}{K}\sum_{k=1}^{K} w_{j2}$$
$$w_{j3} = \frac{1}{K}\sum_{k=1}^{K} w_{j3}, w_{j4} = \max_k\{w_{jk4}\} \qquad \text{Equation 3}$$

As a result, a performance matrix was generated, which is shown in Equation4.

$$\begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \tilde{x}_{13} & \dots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \tilde{x}_{23} & \dots & \tilde{x}_{2n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \tilde{x}_{m3} & \dots & \tilde{x}_{mn} \end{bmatrix} \widetilde{W} = [\widetilde{w}_1, \widetilde{w}_2, \dots, \widetilde{w}_n] \qquad \text{Equation 4}$$

Then, the values of the fuzzy performance matrix were normalized using Equations 5 and 6. These equations are used respectively if maximization and minimization of the criteria of each column is preferred. As for the present research, a maximization was required as the differences between the values

of the pretests and posttests have been used. Therefore, Equation 5 was used for the normalization of the values.

$$\tilde{r}_{ij} = \left[\frac{a_{ij}}{d_j^*}, \frac{b_{ij}}{d_j^*}, \frac{c_{ij}}{d_j^*}, \frac{d_{ij}}{d_j^*}\right], d_j^* = \max_i \{d_{ij}\}, j \in B \qquad \text{Equation 5}$$

$$\tilde{r}_{ij} = \left[\frac{a_j^-}{d_{ij}}, \frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}}\right], a_j^- = \min_i \{a_{ij}\}, j \in C \qquad \text{Equation 6}$$

Using the fuzzy weights derived from Equation 3, the normalized fuzzy performance matrix values were weighted using Equation 7. This equation simply entailed item by item multiplication of the normalized values through corresponding the fuzzy weights.

$$\tilde{V} = [\tilde{v}_{ij}]_{m \times n}, i = 1,2, \dots, m; j = 1,2, \dots, n \qquad \text{Equation 7}$$
$$v_{ij} = \tilde{r}_{ij}(.)\tilde{w}_j$$

Next, the fuzzy positive ideal solution (A^*) (FPIS) and the fuzzy negative ideal solution (A^-) (FNIS) were defined through Equations 8 and 9 that display selection of the maximum values from the fourth column and the minimum values from the first column as the fuzzy positive negative ideal solutions in turn.

$$A^* = (v_1^*, v_2^*, \dots, v_n^*), A^- = (v_1^-, v_2^-, \dots, v_n^-) \qquad \text{Equation 8}$$

$$\tilde{v}_j^* = \max_i \{v_{ij4}\}, \tilde{v}_j^- = \min_i \{v_{ij1}\} \qquad \text{Equation 9}$$

After that, the distances of the weighted normalized fuzzy values from the FPIS and FNIS were calculated using the vertex method shown in Equations 10 and 11.

$$d_i^* = \sum_{j=1}^{n} d_v(\tilde{v}_{ij}, v_j^*), i = 1,2,\dots,m \qquad \text{Equation 10}$$

$$d_i^- = \sum_{j=1}^{n} d_v(\tilde{v}_{ij}, v_j^-), i = 1,2,\dots,m \qquad \text{Equation 11}$$

The vertex method was applied in Equation 12, where $\tilde{m} = (m_1, m_2, m_3, m_4)$ and $\tilde{n} = (n_1, n_2, n_3, n_4)$ were the two trapezoidal numbers.

$$d_v(\tilde{m}, \tilde{n}) = \sqrt{\frac{1}{4}[(m_1 - n_1)^2 + (m_2 - n_2)^2 + (m_3 - n_3)^2 + (m_4 - n_4)^2]} \qquad \text{Equation 12}$$

Simply put, the *n* values were the maximum values selected using Equation 10 for the distance from the FPIS, and the *n* values were the minimum values selected using Equation 11 for the FNIS. In the end, the relative closeness coefficient was calculated for the alternatives using Equation 13.

$$CC_i = \frac{\alpha d_i^- + (1-\alpha) d_i^*}{d_i^* + d_i^-}, i = 1,2,\dots,m \qquad \text{Equation 13}$$

In Equation 13, the numerator was the sum of distances of each alternative for the criteria understudy from the FNIS, and the denominator was the sum of distances of each alternative for the criteria understudy from the FPIS. The CC_i values ranged between zero and one, and the alternative with the highest value ranked first. Moreover, equal and changing weights were used in the process to reveal the effects of the weights on the final results leading to a sensitivity analysis of the results.

Results and Discussion

Table 5 exhibits raw data of the participants' five most recurrent grammatical errors.

Table 5.

Raw Data for TOPSIS in Monolingual Persians and Bilingual Turkmens

Categories	Past Simple		Present Simple		Preposition		Singular/Plural Verb		Indefinite Article (a)	
	MP	**BT**	**MP**	**BT**	**MP**	**BT**	**MP**	**BT**	**MP**	**BT**
OMCF	110	154	73	68	21	35	45	37	22	20
WMCF	164	123	45	76	18	63	12	44	-7	34
OWMCF	114	137	49	82	33	32	41	44	17	7

Monolingual Persians (MP) and bilingual Turkmens (BT)

In Table 5, numbers 110 for the Monolingual Persians (MP) and 154 for the bilingual Turkmens (BT) show a reduction of the errors in the "past simple" as a result of the OMCF treatment. The rest of the table can be interpreted likewise.

Table 6 displays the fuzzy linguistic variables on the basis of the opinion of the five decision-makers (DMs) sought for the criteria priorities of the monolingual Persians and bilingual Turkmens using abbreviations in Table 3.

Table 6.

Criteria Priorities Assigned by Five Experts

Categories	Past Simple	Present Simple	Preposition	Singular/Plural Verb	Indefinite Article (a)
DM1	H	L	VH	H	VH
DM2	H	L	VH	H	VH
DM3	VH	VH	MH	MH	M
DM4	VH	H	M	MH	ML
DM5	H	VH	H	H	MH

Decision Maker: DM

To interpret Table 6, the five experts believed that the errors in the "past simple" were "**H**ighly", "**H**ighly", "**V**ery **H**ighly", "**V**ery **H**ighly", and "**H**ighly" important for the teachers to focus on (second column from left). Other parts of the table can be interpreted in the same way. Based on these views and using Table 3, the raw fuzzy weights were assembled, and the rest of the process was implemented.

Furthermore, the performance priorities of the five decision-makers were solicited which are displayed in Table 7. Here is an example from Table 7 for the "past simple" error category and "OMCF" strategy which is shaded gray. All the decision-makers believed that the performances of the monolingual Persians and bilingual Turkmens have been "**V**ery **G**ood", "**V**ery **G**ood", "**V**ery **G**ood", "**V**ery **G**ood", "**G**ood", "**G**ood", "**V**ery **G**ood", "**V**ery **G**ood", "**G**ood", and "**G**ood" sequentially. Based on these opinions and using the raw fuzzy values in Table 4, the collective fuzzy values for the performances were assembled and processed using the equations mentioned above.

Table 7.

Performance Priorities of Five DMs for Three CF Strategies in Monolingual Persians and Bilingual Turkmens

	CF	**DM1**		**DM2**		**DM3**		**DM4**		**DM5**	
	Strategies	MP	BT	MP	BT	MP	BT	MP	BT	MP	BT
	OMCF	VG	VG	VG	VG	G	G	VG	VG	G	G
Past Simple	WMCF	VG	MG	VG	MG	VG	MG	VG	G	VG	G
	OWMCF	VG	MG	VG	MG	VG	G	VG	G	VG	G
	OMCF	VG	VG	VG	VG	VG	G	VG	VG	VG	G
Present Simple	WMCF	VG	G	VG	G	VG	G	VG	G	G	G
	OWMCF	VG	VG	VG	VG	G	VG	VG	VG	G	VG
	OMCF	G	MG	G	MG	MP	MG	G	G	M	MG
Preposition	WMCF	G	G	G	G	MP	MG	G	G	M	MG
	OWMCF	MG	G	MG	G	MG	M	MG	G	MG	M
	OMCF	MG	G	MG	G	M	MP	MG	G	M	M

	CF Strategies	DM1		DM2		DM3		DM4		DM5	
		MP	BT	MP	BT	MP	BT	MP	BT	MP	BT
Singular/Plural Verb	WMCF	VP	G	VP	G	VP	MG	VP	VG	VP	MG
	OWMCF	G	M	G	M	MP	P	G	P	MP	P
	OMCF	VG	VG	VG	VG	VG	G	VG	VG	G	G
Indefinite Article (a)	WMCF	G	VG	G	VG	MP	G	G	G	M	G
	OWMCF	VG	VG	VG	VG	VG	G	VG	VG	G	G

Monolingual Persians (MP) and Bilingual Turkmens (BT)

The obtained data were subjected to Equations 2 to 13. As such, fuzzy relative closeness coefficients of CF alternatives were derived for the monolingual Persians and bilingual Turkmens (Table 8). The results showed that the OWMCF strategy ranked the first for the monolingual Persians followed very closely by the OMCF strategy. However, the OMCF strategy ranked the first, followed very closely by the WMCF strategy for the bilingual Turkmens.

Table 8.

Relative Closeness of the Alternatives for Monolingual Persians and Bilingual Turkmens

	Strategies	Persians	Turkmens
1	**OWMCF**	0.57	0.46
2	**OMCF**	0.56	0.52
3	**WMCF**	0.47	0.51

Monolingual Persians (MP) and Bilingual Turkmens (BT)

The results of the fuzzy TOPSIS ranking of the CF strategies are displayed in Figure 2.

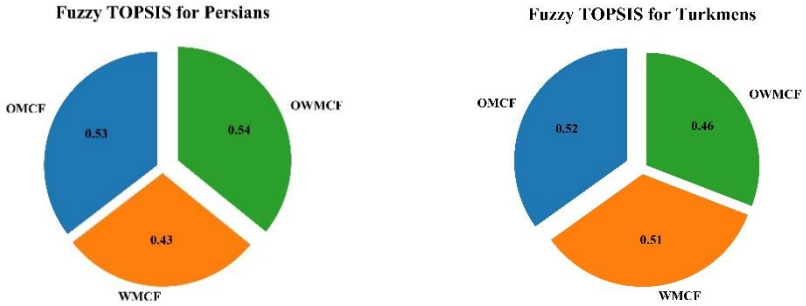

Figure 2.
Ranking Strategies for Monolingual Persians (MP) and Bilingual Turkmens (BT)

The results of running the fuzzy TOPSIS with original fuzzy weights and those with changed weights in 17 experiments are shown in Table 9. Wc1 to Wc5 represents the weights of the five error categories. This process provided a sensitivity analysis of the results. The second and third columns from left depict the weights assigned to the error categories. For instance, the second row shows that Wc1-c5 has been assigned a very low weight (0.0, 0.0, 0.1, & 0.2) using the trapezoidal fuzzy values in Table 3. However, the weights of the error categories have been changed systematically for the five error categories in the next experiments.

Table 9.

Sensitivity Analysis for TOPSIS Ranking

Experiment	Given by Experts Criteria Weights		Ranking for Persians	Ranking for Turkmens
1			OWMCF>OMCF>WMCF	OMCF>WMCF>OWMCF
2	Wc1-c5 = (0.0, 0.0, 0.1, 0.2)	--	OWMCF=OMCF>WMCF	OMCF>WMCF>OWMCF
3	Wc1-c5 = (0.1, 0.2, 0.2, 0.3)	--	OWMCF=OMCF>WMCF	OMCF>WMCF>OWMCF
4	Wc1-c5 = (0.2, 0.3, 0.4, 0.5)	--	OWMCF=OMCF>WMCF	OMCF>WMCF>OWMCF
5	Wc1-c5 = (0.4, 0.5, 0.5, 0.6)	--	OWMCF>OMCF>WMCF	OMCF>WMCF>OWMCF
6	Wc1-c5 = (0.5, 0.6, 0.7, 0.8)	--	OWMCF=OMCF>WMCF	OMCF>WMCF>OWMCF
7	Wc1-c5 = (0.7, 0.8, 0.8, 0.9)	--	OWMCF>OMCF>WMCF	OMCF>WMCF>OWMCF
8	Wc1-c5 = (0.8, 0.9, 1.0, 1.0)	--	OWMCF>OMCF>WMCF	OMCF>WMCF>OWMCF
9	Wc1 = (0.8, 0.9, 1.0, 1.0)	Wc2-c5 = (0.0, 0.0, 1.0,2.0)	OWMCF=OMCF>WMCF	OMCF>WMCF>OWMCF
10	Wc2 = (0.8, 0.9, 1.0, 1.0)	Wc1,c3-c5 = (0.0, 0.0, 1.0,2.0)	OWMCF=OMCF>WMCF	OMCF>WMCF>OWMCF
11	Wc3 = (0.8, 0.9, 1.0, 1.0)	Wc1-c2,c4-c5 = (0.0, 0.0, 1.0,2.0)	OWMCF=OMCF>WMCF	OMCF>WMCF>OWMCF
12	Wc4 = (0.8, 0.9, 1.0, 1.0)	Wc1-c3,c5 = (0.0, 0.0, 1.0,2.0)	OWMCF=OMCF>WMCF	OMCF>WMCF>OWMCF
13	Wc5 = (0.8, 0.9, 1.0, 1.0)	Wc1-c4 = (0.0, 0.0, 1.0,2.0)	OWMCF=OMCF>WMCF	OMCF>WMCF>OWMCF
14	Wc1 = (0.7, 0.8, 0.8, 0.9)	Wc2-c5 = (0.1, 0.2, 0.2, 0.3)	OWMCF=OMCF>WMCF	OMCF>WMCF>OWMCF

Experiment	Given by Experts Criteria Weights		Ranking for Persians	Ranking for Turkmens
15	Wc2 = (0.7, 0.8, 0.8, 0.9)	Wc1,c3-c5 = (0.1, 0.2, 0.2, 0.3)	OWMCF=OMCF>WMCF	OMCF>WMCF>OWMCF
16	Wc3 = (0.7, 0.8, 0.8, 0.9)	Wc1-c2,c4-c5 = (0.1, 0.2, 0.2, 0.3)	OWMCF=OMCF>WMCF	OMCF>WMCF>OWMCF
17	Wc4 = (0.7, 0.8, 0.8, 0.9)	Wc1-c3,c5 = (0.1, 0.2, 0.2, 0.3)	OWMCF=OMCF>WMCF	OMCF>WMCF>OWMCF
18	Wc5 = (0.7, 0.8, 0.8, 0.9)	Wc1-c4 = (0.1, 0.2, 0.2, 0.3)	OWMCF=OMCF>WMCF	OMCF>WMCF>OWMCF

The first row of Table 9, the column "Ranking for Persians", demonstrates that the original weights and assessments of the performance matrix provided by the experts ranked the OWMCF strategy as the best strategy followed very closely by the OMCF strategy (0.54, 0.53). The WMCF strategy was relatively different (0.43) ranking third in the monolingual Persians. The same column in Table 9 shows that 14 out of the 17 experiments ranked the OWMCF and OMCF as the first and best CF strategies for the monolingual Persians while in the remaining 3 experiments, the OWMCF strategy was slightly better than the OMCF strategy. The WMCF strategy was ranked the least effective CF strategy for the monolingual Persians considering the opinions of the experts on the weights of the error categories and also the Persian EFL learners' performance in the pretest and posttest stages. Referring to the first row and the last column of Table 9 for the bilingual Turkmens, it can be seen that the OMCF strategy was ranked the first followed closely by the WMCF strategy (0.52, 0.51); nevertheless, the OWMCF strategy ranked the third (0.46). Moreover, changing the weights

systematically in 17 experiments did not affect the initial results. In other words, the OMCF and WMCF strategies were selected as the best strategies, whereas the OWMCF strategy was known to be the least effective for the bilingual Turkmens.

The results of this research demonstrated that the OWMCF and WMCF strategies were the best CF strategies for the monolingual Persians and bilingual Turkmens respectively indicating not all the learners benefit from the same corrective feedback strategy. The findings of the present research were congruent with some studies indicating the positive role of applying the fuzzy TOPSIS for ranking and selecting the best alternative in the teaching arenas (e.g., Alaa et al., 2019; Hota et al., 2014; Ivanova & Zlatanov, 2019; Khaki & Heidari Tabrizi, 2021; Khoshi et al., 2018; Moayeri et al., 2015; Shahballa & Alamdar Youli, 2012; Shahballa et al., 2019; Pavani et al., 2013). Based on these results, it can be inferred with high certainty that given different opinions of the experts, the OWMCF and OMCF strategies have been the best choices for the monolingual Persians while the OMCF and WMCF strategies were more effective for the bilingual Turkmens.

The usefulness of the process emanates from the fact that all different views have been included in the process, and no academic member can claim partiality in deriving the results. Furthermore, it provides a means of repeating the experiments with many different weights assuring relative consensus among the EFL/ESL teachers with different views. Eventually, language backgrounds and ethnicities might play roles in the effectiveness of different CF strategies. The L2 teachers should be aware of the mediating variables in their choice of CF in general and with regard to bilingual language learners in particular. In cases of small sample size or disagreement among the experts, fuzzification might ensure representation of the experts' conflicting ideas

leading to a possible consensus. The present study exemplifies such an application benefiting from the potentials of fuzzy logic to resolve varied opinions. The present research indicated how the fuzzy TOPSIS allows EFL/ESL teachers' voices to be heard in the decision-making process regarding various CF strategies. Therefore, the EFL/ESL teachers may participate in the process and adjust their CF strategies accordingly.

Conclusion

The present study was an attempt to bridge the gap in the body of literature pertinent to the effect of various metalinguistic CF strategies namely, mid-focused OMCF, WMCF, and OWMCF on the five most recurrent grammatical errors of the monolingual Persians compared to those of the bilingual Turkmens. Ranking the strategies was implemented through the fuzzy TOPSIS approach. A performance matrix was constructed on the five error categories (the criteria) as a result of the three CF strategies (the alternatives) for the monolingual Persians and bilingual Turkmens. The process provided a means of including varied opinions of DMs in a collective manner, thus paving the way for relative consensus on the best CF strategies for the EFL learners.

On the whole, the analyses indicated the robustness of the initial results and confirmed the conclusions made as to the best strategies for both groups of EFL learners. Out of the three CF strategies, the OWMCF and OMCF strategies were the most effective ones for the monolingual Persians, whereas the OMCF and WMCF strategies exerted more effect in the bilingual Turkmens. Moreover, the significance of the approach lies in the fact that the results can be the least disputed by the experts as their opinions have been included in the process of determining the best choice of CF strategy through

fuzzy logic. Even in cases when some of the concerned teachers dispute the results, they can participate in the process quite easily and provide their fuzzy views and see the results. Studies of this kind can clarify the questions raised when different CF strategies are introduced to the EFL/ESL teachers' community.

Errors committed by the monolingual Persians and bilingual Turkmens might be a valuable source for the EFL teachers as well as learners. The fuzzy TOPSIS approach employed in the present study took the quote "one size does not fit all" from Bitchener and Ferris (2012) into consideration and displayed that the EFL/ESL learners' errors might inform EFL/ESL teachers, language scholars, syllabus designers, and materials developers (Cohen, 2018). In line with Kumaravadivelu's (2006) parameter of particularity, localization of language teaching adopted and developed in this study seems to be very beneficial. Having the knowledge and equipped with varieties of corrective feedback strategies for EFL/ESL learners with dissimilar L1(s) and in diverse contexts, teachers can organize their instructional materials beforehand, be more efficient, and save a substantial amount of class time.

Generalization of the results ought to be done with caution since the study was conducted at two language institutes and among a limited number of Persian and Turkmen EFL learners. Further research is encouraged on other proficiency levels employing other corrective CF strategies. Based on the present research, an avenue for future endeavors is opened among bilinguals and perhaps multilinguals. Future research is also recommended with more experts encouraging the active involvement of those concerned about the likely results. Analyses with larger data sets using statistical methods may also shed more light on the results derived from such studies.

Acknowledgments

The authors express their gratitude to Mr. Abdoljalil Bahalkeh, head of the Zabankadeh Melli in Simin Shahr, all the staff, and learners. The authors are also thankful to the educational managers, staff, and learners of the Ofogh language institute in Gorgan. The researchers also appreciate all the help of the participants. Likewise, special thanks go to reviewers for their invaluable comments.

Declaration of Interest Statement: The authors declare no conflict of interests.

Funding: This was a private research project and was not supported by any institutes.

References

Aghajanloo, K., Mobini, F., & Khosravi, R. (2016). The effect of teachers' written corrective feedback types (WCF) on intermediate EFL learners' writing performance. *Advances in Language and Literary Studies, 7*(3), 28-37.

Ahmadian, M., Mehri, E., & Ghaslani, R. (2019). The effect of direct, indirect, and negotiated feedback on the linguistic accuracy of EFL learners in writing. *Issues in Language Teaching*, *8*(1), 1-32.

Al Mubarak, A. A. (2017). An investigation of academic writing problems level faced by undergraduate students at Al Imam Al Mahdi University-Sudan. *English Review: Journal of English Education*, *5*(2), 175-188.

Alaa, M., Albakri, I. S. M. A., Singh, C. K. S., Hammed, H., Zaidan, A. A., Zaidan, B. B., Albahri, O. S., Alsalem, M. A., Salih, M. M., Almahdi, E. M., Baqer, M. J., Jalood, N. S., Nidhal, S., Shareef, A. H., & Jasim, A. N. (2019). Assessment and ranking framework for the English skills of pre-service teachers based on fuzzy Delphi and TOPSIS methods. *IEEE, 7*, 201-223.

Al-Hammadi, A. S., & Milne, R. H. (2004). A neuro-fuzzy classification approach to the assessment of student performance. *Proceedings of the 2004 IEEE International Conference on Fuzzy Systems, Hungary,* 837-841. **doi:** 10.1109/FUZZY.2004.1375511

Amin, M. Y., & Saadatmanesh, S. (2018). Discovering the effectiveness of direct versus indirect corrective feedback on EFL learners' writings: A case of an Iranian context. *International Journal of Humanities and Cultural Studies, 5*(2), 171-181.

Bitchener, J. & Knoch, U. (2008). The value of written corrective feedback for migrant and international students. *Language Teaching Research, 12*(3), 409-431.

Bitchener, J. (2008). Evidence in support of written corrective feedback. *Journal of Second Language Writing, 17*(2), 102-118.

Bitchener, J., & Ferris, D. R. (2012). *Written corrective feedback in second language acquisition and writing.* New York: Routledge.

Bitchener, J., & Knoch, U. (2009). The relative effectiveness of different types of direct written corrective feedback. *System, 37*(2), 322-329.

Bitchener, J., & Knoch, U. (2010). The contribution of written corrective feedback to language development: A ten-month investigation. *Applied Linguistics, 31*(2), 193-214.

Bitchener, J., & Storch, N. (2016). *Written corrective feedback for L2 development.* Toronto: Multilingual Matters.

Bitchener, J., Young, S., & Cameron, D. (2005). The effect of different types of corrective feedback on ESL student writing. *Journal of Second Language Writing, 14*(3), 191-205.

Carless, D. (2006). Differing perceptions in the feedback process. *Studies in Higher Education, 31*(2), 219-233.

Chandler, J. (2003). The efficacy of various kinds of error feedback for improvement in the accuracy and fluency of L2 student writing. *Journal of Second Language Writing, 12*(3), 267-296.

Cohen, A. D. (2018). Reflections on a career in second language studies: Promising pathways for future research. *L2 Journal, 10*(1), 1-19.

Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in education* (8th ed). London: Routledge.

Du, J. (2018). Evaluation method of English teaching quality based on a fuzzy comprehensive evaluation. *International Conference on Intelligent Transportation, Big Data & Smart City (ICITBS)*, Xiamen, 661-664. **: doi:**10.1109/ICITBS.2018.00172

Duc, D. A., Thach, P. N., Phuong, B. H., Dung, C. C., Van, L. H., & Diep, P. T. H. (2019). A dynamic fuzzy multiple criteria decision-making approach for lecturer performance evaluation. *Journal of Management Information and Decision Sciences, 22*(3), 250-261.

Eastwood, J. (2003). *Oxford practice grammar for intermediate* (2nd ed). Oxford: Oxford University Press.

Ebadi, E. (2014). The effect of focused metalinguistic corrective feedback on Iranian intermediate EFL learners' essay writing ability. *Journal of Language Teaching and Research, 5*(4), 878-883.

Ellis, R. (2009). A typology of written corrective feedback types. *ELT Journal, 63*(2), 97-107.

Ertuğrul Í., & Karakaşoğlu, N. (2007). Fuzzy TOPSIS method for academic member selection in engineering faculty. In Iskander M. (ed.), *Innovations in E-learning, Instruction Technology, Assessment, and Engineering Education* (pp. 151-156). The Netherlands: Springer.

Eslami, Z., & Derakhshan, A. (2020). Promoting advantageous ways for teachers and learners to deal with corrective feedback. *Language Teaching Research Quarterly, 19*(special issue), 48-65.

Fedrizi, M., & Molinari, A. (2013). A multi-expert fuzzy TOPSIS-based model for the evaluation of e-learning paths. *Proceedings of the Eighth Conference of the European Society for Fuzzy Logic and Technology (EUSFLAT),* Italy, 554-558. doi: 10.2991/eusflat.2013.84

Ferris, D. R. (1999). The case for grammar correction in L2 writing classes: A response to Truscott (1996). *Journal of Second Language Writing, 8*(1), 1-11.

Ferris, D. R. (2010). Second language writing research and written corrective feedback in SLA. *Studies in Second Language Acquisition, 32*(2), 181-201.

Ferris, D. R. (2011). *Treatment of error in second language student writing*. (2nd ed). Ann Arbor: University of Michigan Press.

Ferris, D. R. (1995). Teaching students to self-edit. *TESOL Journal, 4*(4), 18-22.

Hosseini Bay, Z., & Dehghan, M. (2019). The effects of gradual and indirect feedback on EFL learners' grammar development and beliefs. *Journal of Teaching Language Skills, 38*(2), 81-106.

Hota, H. S., Sharma L. K., & Pavani, S. (2014). Fuzzy TOPSIS method applied for ranking of teacher in higher education. In M. Durga Prasad and P. Srikanta (eds.), *Intelligent computing, networking, and informatics:*

Proceedings of the international conference on advanced computing, networking, and informatics (pp.1225-1233). New York: Springer.

Hwang, C. L., & Yoon, K. (1981). *Multiple attribute decision-making:* Methods and applications. Berlin: Springer-Verlag.

Hyland, K., & Hyland, F. (2006). Feedback on second language students' writing. *Language Teaching, 39*(2), 83-101.

Ivanova, V., & Zlatanov, B. (2019). Application of fuzzy logic in online test evaluation in English as a foreign language at the university level. *Proceedings of the 45th International Conference on Application of Mathematics in Engineering and Economics*, 1-8. doi: org/10.1063/1.5133519

Johns, A. M. (1995). Genre and pedagogical purposes. *Journal of Second Language Writing, 4*(2), 181-190.

Karim, K. & Nassaji, H. (2019). The effects of written corrective feedback: A critical synthesis of past and present research. *Instructed Second Language Acquisition, 3*(1), 28-52.

Khaki, M., & Heidari Tabrizi, H. (2021). Assessing the effect of direct and indirect corrective feedback in process-based vs product-based instruction on learners' writing. *Language Teaching Research Quarterly, 21*, 35-53.

Kheradmand Saadi, Z., & Saadat, M. (2015). Iranian EFL learners' grammatical knowledge: Effect of direct and metalinguistic corrective feedback. *English Language Teaching, 8*(8), 112-120.

Khoshi, A., Gooshki, H. S., & Mahmoudi, N. (2018). The data on the effective qualifications of teachers in medical sciences: An application of combined fuzzy AHP and fuzzy TOPSIS methods. *Data in Brief, 21*, 2689-2693.

Kumaravadivelu, B. (2006). *Understanding language teaching:* From method to postmethod. Mahwah: Lawrence Erlbaum.

Liu, Q., & Brown, D. (2015). Methodological synthesis of research on the effectiveness of corrective feedback in L2 writing. *Journal of Second Language Writing, 30*(4), 66-81.

Liu, Y. (2015). Research on the foreign language teaching effectiveness evaluation with intuitionistic fuzzy information. *Journal of Intelligent and Fuzzy Systems, 28*(2), 787-793.

Lyster, R. M., & Ranta, L. (1997). Corrective feedback and learner uptake: Negotiation of form in communicative classrooms. *Studies in Second Language Acquisition, 19*(1), 37-66.

Moayeri, M., Shahvarani, A., Behzadi, M. H., & Hosseinzadeh-Lotfi, F. (2015). Comparison of fuzzy AHP and fuzzy TOPSIS methods for math teacher selection. Indian Journal of Science and Technology, *8*(13), 1-10.

Murphy, M., & Smalzer, W. R. (2009). *Grammar in use for intermediate*. (3rd ed). Cambridge: Cambridge University Press.

Nădăban, S., Dzitac, S., & Dzitac, I. (2016). Fuzzy TOPSIS: A general view. *Procedia Computer Science, 91*, 823-831.

Nassaji, H. (2017). The effectiveness of extensive versus intensive recasts for learning L2 grammar. *The Modern Language Journal*, *101*(2), 353-368.

Nassaji, H., & Kartchava, E. (eds.) (2017). *Corrective feedback in second language teaching and learning*: Research, theory, applications, implications. New York: Routledge.

Pavani, S., Sharma, L. K., & Hota, H. S. (2013). A group expert evaluation for teachers by integrating fuzzy AHP and TOPSIS models. *Proceedings of IEEE International Conference in MOOC, Innovation and Technology in Education (MITE), India*, 85-90. **doi:** 10.1109/MITE.2013.6756311

Pedrycz, W., Ekel, P., & Parreiras, R. (2011). *Fuzzy multi-criteria decision-making models, methods, and applications.* U.K: Wiley.

Rezaei, S., & Derakhshan, A. (2011). Investigating recast and metalinguistic feedback in task-based grammar instruction. *Journal of Language Teaching Research*, *2(*3), 655-663.

Sadat, T., Zarifi, A., Sadat, A., & Malekzadeh, J. (2015). Effectiveness of direct and indirect corrective feedback on Iranian EFL learners' accuracy and retention of conditional sentences types I, II &III. *Theory and Practice in Language Studies*, *5*(10), 2023-2028.

Sahin, B., Leung Yip, T. L., Tseng, P. H., Kabak, M., & Soylu, A. (2020). An application of a Fuzzy TOPSIS multi-criteria decision analysis algorithm for dry bulk carrier selection. *Information*, *11(5)*, 1-16.

Salehi, M., & Bahrami, A. (2018). An error analysis of journal papers written by Persian authors. *Cogent Arts and Humanities*, *5*(1), 1-16.

Schulze, M., & Smith, B. (2015). In theory, we could be better. *CALICO Journal*, *32*(1), 1-6.

Shafiee Sarvestani, M., & Pishkar, K. (2016). The effect of written corrective feedback on the accuracy of English article usage in L2 writing. *Journal of Applied Linguistics and Language Research*, *3*(1), 110-120.

Shahballa, A. H., & Alamdar Youli, F. (2012). Reading comprehension of different genres: A fuzzy approach. *International Journal of English Linguistics, 2*(1), 17-27.

Shahballa, A., Ghonsooly, B., & Karami, H. (2019). Developing and validating a new version of an EFL multiple-choice reading comprehension test based on fuzzy logic. *Journal of Language Horizons, 3(*1), 71-92.

Sinha, S. (2017). Fuzzy logic-based teaching/learning of a foreign language in multilingual situations. *Acta Linguistica Asiatica, 7*(2), 71-84.

Sobrino, A. (2013). Fuzzy logic and education: Teaching the basics of fuzzy logic through an example (by way of cycling). *Education Sciences*, *3*(2), 75-97.

Truscott, J. (1996). Review article: The case against grammar correction in L2 writing classes. *Language Learning, 46*(2), 327-369.

Wang, R. (2016). Improvement of flipped classroom teaching model based on fuzzy comprehensive evaluation model. *The Eighth International Conference on Measuring Technology and Mechatronics Automation, China,* 335-338. doi**:** 10.1109/ICMTMA.2016.88

Zadeh, L. A. (1965). Fuzzy sets. *Information and Control*, *8*(3), 338-353.

Zadeh, L. A. (2008). Is there a need for fuzzy logic? *Information Sciences, 178*(13), 2751-2779.