SOFT COMPUTING IN DECISION MAKING AND IN MODELING IN ECONOMICS

Multi-criteria decision making for determining best teaching method using fuzzy analytical hierarchy process

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Abstract

During the outbreak of COVID-19, information technology played a critical role in promoting education all around the world. Online teaching boosts students' learning processes and has a good impact on their learning during the epidemic. Big data technology transforms traditional teaching approaches and learning processes by providing a rich learning resource for diverse teaching elements and improving teachers' teaching techniques. Due to the COVID-19 epidemic, online education spread quickly, and traditional instruction was abruptly switched to online mode, posing a number of issues for students and management. Choosing a decent teaching technique is not an easy option, and it is even more difficult when it comes to selecting the approach. We used the Fuzzy Analytical Hierarchy Process (Fuzzy AHP) method to evaluate four instructional methods based on seven criteria to solve this challenge. Fuzzy AHP is a powerful, simple, and direct way for determining which approach is the most efficient and effective. To simplify the selection process and address the issue of uncertainty, the Fuzzy AHP technique employs the geometric mean method. The Fuzzy AHP approach was found to be efficient and successful in the decision-making process in this study.

Keywords Teaching methods · Teaching · Epidemic situation · Fuzzy AHP · Information technology

1 Introduction

Due to the outbreak of the COVID-19 pandemic, traditional teaching methods are broken because of social distancing and school closures all around the world. While the internet and education have become the perfect topic to enhance the teaching mode during an epidemic to help the students, teachers, and institutes for a better learning process. During the epidemic, information technology solved and improved the students' and teachers' issues of learning through the online teaching mode, but the COVID-19 pandemic has exposed several issues in online teaching that were faced by the tutors and students during the classes. Online teaching played a key role during the COVID-19 pandemic and broadly promoted education around the globe. Correct recognition of learners' education modes in the virtual teaching of ideological and political teaching processes is useful to enhance the learners' focus in the education mechanism and improve the impact of online teaching of ideological and political teaching. Due to the speedy development of computer technology, the use of big data technology in the subject of ideological and political theory teaching is more general. The online teaching mode also brings a lot of enhancement in traditional education and brings several challenges because of the sudden change from traditional teaching to online teaching because of the COVID-19 outbreak. Online teaching during the epidemic situation enhances the students' learning process and has a positive impact on students' learning.

Jie (2021) has proposed a study that virtual teaching is a recent academic approach with the advancement of modern information technology. In time of the existing epidemic prevention and control interval, virtual teaching can assist in education like no classes are suspended and not stop

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teaching. It is also a measure of not disturbing the other activities of students like papers, work etc., by creating a better using of Internet big data. The study examines the existing complications of virtual teaching in institutes, then keep onwards efficient ways for the current issues to maximize the possessions of virtual teaching. Chen et al. (2020) have recommended a study in order to present the importance of big data intelligent ideological and political academic research in institutes in the recent era, as well as abstracts the study state of primary technologies of ideological and political learning in institutes, also puts onward the big data intelligent ideological and political education classroom in institutes and primary technologies of its pattern. The study further demonstrates "class postponement and keep schooling" the operational process of model and component of the front-end interface display are shown in order to provides recommend for the research of big data intelligent and political academic purpose and learning information data center. Liu (2020) has suggested in order to designs the virtual teaching resources diversified incorporation of ideological along with political subject in institutes under the contextual of big data. The resource service system and teaching resource platform are incorporated through a diversified integration method in order to meet the education essentials of college learners. The outcomes showed that after the usage of diversified integration approach, the students' scores of the theoretical subject have been improved efficiently. On the basis of this result, its identified that diversified integration approach has a particular efficiency.

During the COVID-19 pandemic, the education zone is also affected; because of this issue the internet plus education topic become very popular in order to make the education virtual throughout the world. Peng et al. (2020) have presented a study which examines the features of information-based teaching in the epidemic conditions. In addition, the study negotiates solution of incorporation information methods along with teaching in merging the "Internet and education" benefits as well as traditional teaching of classroom. Probably the study provides better chances and fresh way for upcoming education advancement. Online education spread and develop rapidly during the COVID-19 pandemic but as compared to physical teaching mode, virtual teaching mode is not good enough due to its short development interval. On the basis of this, Cai (2020) has focused a study in order to elaborate an efficient assessment system by carrying out large-scale data investigation and statistics that deal with the large-scale airing teaching approach in time of the epidemic interval. At first, pointing at the manipulating factors of online live broadcast teaching method and the weight of every individual factor, after this, by incorporating all levels of institutes in order to developed the assessment system of online live broadcast teaching mode. At the end, the accomplished online live broadcast teaching approach enhanced and boosted in contrast with traditional teaching approaches. Following are the contributions of the proposed approach:

- To use the Fuzzy AHP method to evaluate four instructional methods based on seven criteria to solve this challenge.
- Fuzzy AHP is a powerful, simple, and direct way for determining which approach is the most efficient and effective.
- To select the process and address the issue of uncertainty, the Fuzzy AHP technique employs the geometric mean method.

2 Literature study

Several research works have been carried out to determine effective teaching approaches. Chi et al. (2021) have developed a study that presents an innovative teaching method as well as teaching technique based on superstar platform, nail live broadcast, shiver teaching assistant along with virtual teaching and answering in the particular interval of recent coronavirus, and also combine with the progression of ideological and political learning according to epidemic condition. The study and experiment outcome indicate that online as well as offline hybrid teaching method can get the better tutoring effect as compared to classroom and physical teaching method. Sun (2020) has addressed a study in order to elaborate the spirit as well as consciousness logic of ideological and political learning by using the theory and procedure of culture. The study negotiates the significance of ideological along with political advancement of course syllabus in liberal arts mathematics learning as well as its academic thought technique and also examines the workings of cultural learning and scientific learning in liberal arts mathematics universal subject. Furthermore, the study examines the important usage of cultural along with scientific quality in the course liberal arts mathematics regarding the two perspectives of tutoring content as well as tutoring means.

Li and Song (2021) have recommended that virtual teaching has both chances and trials. But the primary complications which are highlighted in the analysis are that how to grasp and adjust to the condition, support training along with policy motivations, launch quality guarantee management along with investigation and connection procedure, also actively discover the improvement method. In addition, the study reviews the real-world practice of virtual tutoring in order to examines the limitations of virtual teaching, and discover the virtual plus offline hybrid

tutoring, also encourages local institutes in order to enhance their instructing method. Xue and Li (2021) have suggested an analysis that analyzes the major trials and primary complications for the education system in order to answer to the foremost community disaster. At the end, the ways of the academic system to deal with the primary community disaster focus on launching a multiple sections management system for the purpose to response the academic emergency; creating permanent institution to supervised the academic emergency, solidification institutional building and expresses guidelines for disaster reply; elevating the manufacture of the operation system in order to enhance the process for disaster reaction; enhancing the security system as well as improve the ability of comprehensive reaction, along with instituting an initial caution process for learning in answer to community disaster.

Liu (2021) has proposed a study that the strategy of novelty and entrepreneurship tutoring system for colleges ideological and political subjects based on virtual and offline incorporation are presented. Mysql multi-threaded database is used as the system database as well as using the collaborative filtering in order to measure the allocation of tutoring resources. Formulate working modules and construct a mixed tutoring method, according to the needs of the virtual and offline incorporation. The practical outcomes show that the system come across the design operational needs, the occupancy ratio of server is small, as well as it has assured viability. Zhai (2021) has presented a study that primarily analyzes the utility optimization as well as stable matching technique of UDRN based on EH and restricted character input, the nodes are divided into several groups, and the utility optimization technique is employed in the groups. Model consumers and relays as energy buyers and sellers. At first, when consumers select relays as their candidates, the golden section approach is utilized in order to get the better relay power to maximize consumer efficacy. On the basis of principle of maximizing the efficacy of matching, a mutual reference matrix among consumers along with relays is recognized. This algorithm is very important in the psychological renovation of doctors after the epidemic.

Deák et al. (2021) have focused in order to examine innovative models which are developed recently. In recent times, STEM incorporation and classroom interaction are main methods in learning. The objective of the study is to provide instructors with some analytical equipment to complement the upgrading of STEM learning. An innovative PESTLE model is outlined for attempting the alterations in learnings in time of epidemic as well as crises. Analysis-based education can speed up the reason of incorporating courses in STEM learning. Additionally, the study negotiates the post-epidemic situation of pedagogy in the education system. Dwivedi et al. (2020) have suggested

a study that provides a cooperative perception to the several primary complications and underlying complexities affecting industries as well as public from COVID-19, via a technological perception and information systems. The opinions of twelve professionals of course are collected and examined where each articulate their individual perception relating to: virtual learning, digital approach, AI, public communication, cyber security, big data, mobile technology, privacy and approach via the lens of the existing disaster as well as impact on these particular zones. The professional perceptions provide in time insight to the scope of subjects and finding primary complications.

Duan (2021) has recommended a study in order to incorporate political and ideological work throughout the overall procedure of education and teaching, thus as to achieve the overall development and overall education. During the particular interval of fighting against COVID-19, its most necessary to elaborate the balance among linguistic teaching and ideological plus political education by utilizing some recent technologies in order to grasp the learning of patriotism to learners. Furthermore, the study illustrates how to incorporate ideological plus political education into broad English by utilizing the cloud platform from five perceptions: academic philosophy, tutors, teaching content, assessment approaches and teaching approach.

Dong et al. (2017) have developed a study that utilizes mathematical model to investigate the ideological and political trend in institutes in the information era. At first, the positive and negative impacts of the network media atmosphere on ideological and political learning in institutes are examined, as well as particular countermeasures as given according to the negative impact in which include: to raise the construction of the ideological and political learning platform within campus network media and improve the usage of network media advancement in the purpose of ideological and political in institutes in order to maximize the network media benefits and promote the efficiency of political and ideological learning. Bai (2021) has proposed a study in order to examine the benefits, application core and technical nature of big data technology. Further studies give the particular uses of big data technology in the allocation of subjects, data gathering, data processing, and data statistical investigation and it is also studied that how to do better in survey approach coaching, how to enhance the data management system, and how to strengthen the syllabus construction of institutes. In addition, the study purpose is to improve the quality of big data technology and enhance the consistency of specific survey outcomes of political as well as ideological subjects.

3 Methodology

Big data technology provides a healthy teaching resource for several teaching elements and also enhances the teaching strategy for tutors, which changes the traditional learning process and teaching techniques. The incorporation of big data technology into higher education is of great importance in practice to enhance the quality of education and also improve the comprehensive worth of college learners. Information technology has brought a lot of alterations in lifestyles and also affected the construction of ideological and political education. Due to the enhancement of IoT based smart systems, a huge volume of data is generated every day. Big data technology has brought a lot of opportunities and challenges for the inventive development of ideological and political education in institutes. Nowadays, big data technology is developed and used broadly in current situations. Big data technology integrated into education is the main trend of today, and the utilization of big data technology in learning management is also a primary subject. Big data technology has a positive impact on the education process and smoothly handles the mechanism of education management.

The current research has used Fuzzy AHP method to evaluate four instructional methods based on seven criteria to tackle this problem. The Fuzzy AHP technique uses the geometric mean method to simplify the selection process and handle the issue of uncertainty. In this study, the Fuzzy AHP technique was proven to be effective and efficient in the decision-making process.

3.1 Fuzzy AHP

Fuzzy Analytical Hierarchy Process is a method of AHP that was developed with fuzzy logic theory. The usage of the Fuzzy AHP method is the same as the AHP method. It is only that the Fuzzy AHP method sets the AHP scale into the fuzzy triangle scale to be retrieved with precedence (Putra et al. 2018). The Fuzzy AHP method is a multi-criteria decision making technique having varied usage. The Fuzzy AHP technique aids in reaching decisions with a variety of preferences that include fuzziness and uncertainty (Patil 2018). We read the literature review and identified the goal, criteria, and alternatives, then made a figure for it. Here, the goal is to "select the best teaching method" while the criteria are "quality, interactive, accuracy, efficiency, performance, flexibility, and accessibility". In addition, we take the teaching method as an alternative and give it a general name, such as method 1, method 2, method 3, and method 4, as shown in Fig. 1.

3.1.1 Feature extracted

For the purpose of features gathering, we carefully read the literature review and gathered some common features from them as shown in Table 1.

3.1.2 Selected feature

After the identification of common features from literature review, we take seven features from them for the calculation of useful and effective teaching method with the help of Fuzzy Analytical Hierarchy Process (FAHP) method as shown in Table 2.

3.1.3 Fuzzy AHP for weight calculation using geometric mean method

The decision matrix is made for it and gives values which are given below:

Step 1. Draw a pairwise decision matrix n*n.

$$A = \begin{bmatrix} a11 & \dots & a1n \\ a21 & \dots & a2n \\ an1 & \dots & ann \end{bmatrix} \tag{1}$$

Step 2. Give fuzzy numbers to each criteria. For reciprocal the formula is:

$$A^{-1} = (l, m, u)^{-1} = (1/u, 1/m, 1/l) \tag{2}$$

where l is lower number, m is middle number, and u is upper number.

Step 3. We calculate the fuzzy geometric value by the given formula.

Fuzzy geometric value (r_i)

$$\begin{aligned} &= A_1 * A_2 \dots * A_n \\ &= ((l_1, m_1, u_1) * (l_2, m_2, u_2) * (l_3, m_3, u_3) * \dots \dots * (l_n, m_n, u_n)) \\ &= \left((l_1 * l_2 * l_3 * \dots \dots * l_n)^{1/n}, \right. \\ &\quad \left. (m_1 * m_2 * \dots \dots * m_n)^{1/n}, (u_1 * u_2 * \dots \dots * u_n)^{1/n} \right) \end{aligned} \tag{3}$$

where "n" present the number of criteria.

Step 4. For calculating the fuzzy weights (W_i), we know the formula which is;

$$W_i = r_i * (r_1, r_2, r_3, \dots \dots, r_{10})^{-1}$$
$$\text{OR Fuzzy weights } (W_i), W_I = r_I \cdot (r_1 \cdot r_2 \cdot r_n)^{-1} \tag{4}$$

Step 5. Defuzzification: weights are calculated through the following formula:

$$\text{Center of Area}(w_i) = l + m + u/3 \tag{5}$$

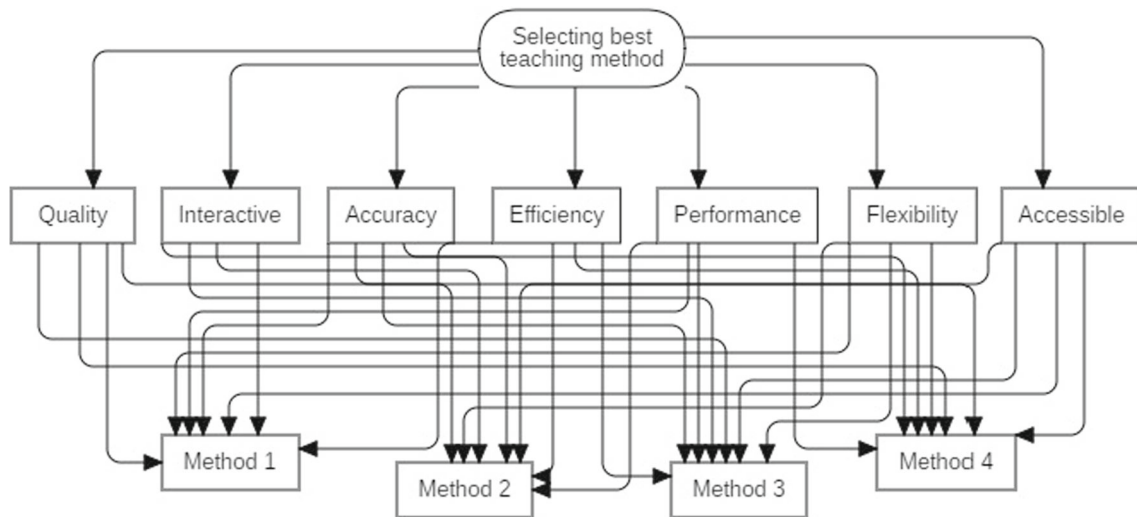by using the above average formula, we calculate the weights from fuzzy weights.

Fig. 1 Goal, criterions and alternatives

Table 1 Feature Extracted

Citations	Features
Cai (2020)	Efficiency, Quality, Flexibility, Interactive
Chi et al. (2021a)	Interactive, Quality, Knowledge, Efficiency, Feasible
Xue and Li (2021)	Flexibility, Responsive, Effective, Efficiency, Accuracy, Performance
Zhai. (2021)	Efficiency, Complexity, Performance, Cost, Scalability
Dwivedi et al. (2020)	Efficiency, Availability, Interactive, Effective, Quality, Accessible, Flexible, Reliability
Duan (2021)	Effective, Knowledge, Measureable, Feasible
Dong et al. (2017)	Efficiency, Quality, Interactive, Effective, Knowledge
Bai (2021)	Reliability, Accuracy, Quality, Effective, Efficiency, Knowledge
Han (2021)	Quality, Efficiency, Interactive, Knowledge
Zhou (2020)	Flexible, Accessible, Efficiency, Interactive, Quality
Xue et al. (2021)	Quality, Effective, Accuracy, Interactive, Efficiency, Realistic
Tuaycharoen (2021)	Efficiency, Quality, Reliability, Accessible, Effectiveness
Tan (2021)	Efficiency, Quality, Interactive, Helpful, Accessible, Effectiveness
Jiang (2021)	Interactive, Efficiency, Knowledge, Performance
Liu et al. (2021)	Interactive, Efficiency, Reliability, Validity
He (2021)	Efficient, Quality, Interactive, Speed, Efficiency, Performance, Accuracy
Zhu (2016)	Interactive, Flexible, Effectiveness, Knowledge
Liang (2020)	Storage, Interactive, Effectiveness, Quality, Efficiency, Accuracy
Feng and Jiang. (2019)	Knowledge, Effectiveness, Qualitative, Effective
Wang and Zhang (2019)	Quality, Stability, Authenticity, Accuracy, Reliable, Effectiveness
Wang (2021)	Sensitivity, Accuracy, Efficient, Effectiveness, Quality
Yi (2021)	Reliability, Quality, Effective, Knowledge, Storage
Tong (2020)	Quality, Knowledge, Performance
Zhao et al. (2020)	Quality, Effective, Quantitative
Yu (2021)	Efficiency, Interactive, Effectiveness, Flexibility, Authenticity, Accessibility
Gao (2019)	Quality, Effectiveness, Efficiency, Accuracy, Sustainable

Table 2 Selected features

Serial no.	Selected features
1	Quality
2	Interactive
3	Accuracy
4	Efficiency
5	Performance
6	Flexibility
7	Accessible

Step 6. If the total sum of weights is greater than 1 transform it to normalized form. The formula for normalized weights is,

$$\text{Normalized Weights} = \frac{w_i}{\sum^i w_i} \quad (6)$$

Table 3 describes the fuzzy scale and Table 4 shows the intermediate values.

By implementing step 1, we draw a pair-wise decision matrix of n*n where "n" represents the number of criteria. By using the given table, we calculate the weightage of each criteria and rank them as shown in Table 5.

On the basis of above pair-wise comparison matrix and following step 2, we draw a fuzzified pair-wise comparison matrix which contains fuzzy numbers and process called fuzzification. The fuzzified pair-wise comparison matrix is shown in Table 6.

In the given Table 7, we calculate the fuzzy geometric value through given formula in step-3. By using the formula given in step-3, we multiply low with low, middle with middle and upper with upper and take nth root on it, where "n" denotes the number of criteria which is "7" here.

Here we executed step 4 to 6. First we applied the fuzzy weights formula to calculate the fuzzy weights values and repeat it for each criterion. After this, we applied the "center of area" formula through which we calculate the average of fuzzy weights and find out the weightage of each criteria. In order to check that the weightage is in normalized form or not, we add all the weightage values to find the sum. So the value of its sum is greater than 1 which mean the weightage is not in normalized form. For normalized weightage, we used given formula and convert it to normalized form as shown in Table 8.

Table 3 Fuzzy scale

Equal	Moderate	Strong	Very strong	Extremely strong
1	3	5	7	9
(1, 1, 1)	(2, 3, 4)	(4, 5, 6)	(6, 7, 8)	(9, 9, 9)

Table 4 Intermediate values

Intermediate values			
2	4	6	8
(1, 2, 3)	(3, 4, 5)	(5, 6, 7)	(7, 8, 9)

Figure 2 shows us the weightage value along with ranking of criterion such as Quality has high weightage value by following Accuracy and so on.

Repeat steps 1 to 6 for all levels of the hierarchy, view tables 5, 6, 7, 8, 9, 10, 11, 12, 13, 14.

We draw an alternatives pair-wise comparison matrix based on Quality criteria. For finding the normalized weightage of alternatives, we applied the steps from 1 to 6 and get the weightage values of each alternatives as shown in Table 9.

We draw a pair-wise comparison matrix based on Interactive criteria. For the purpose of normalized weightage calculation, we executed the above available steps from 1 to 6 as shown in Table 10.

Here, we draw a pair-wise comparison matrix of alternatives based on Accuracy criteria and calculate the normalized weightage of alternatives by using the above steps from 1 to 6 as shown in Table 11.

We draw a pair-wise comparison matrix of n*n, where n represent the number of alternatives. In order to calculate the normalized weightage of alternatives based on Efficiency criteria, we used the above steps from 1 to 6 as shown in Table 12.

To calculate the normalized weightage of alternatives based on Performance criteria, we executed above steps from 1 to 6. Also draw a pair-wise comparison matrix of 4*4. Table 13 describes the alternatives pair-wise comparison matrix based on performance criteria.

We draw a pair-wise comparison matrix of alternatives based on Flexibility criteria. For the identification of normalized weightage of alternatives, we applied steps from 1 to 6 as shown in Table 14.

We draw an alternatives pair-wise comparison matrix of 4*4 based on Accessible criteria. For the purpose of finding normalized weightage, we execute steps 1 to 6 to get the normalized values as shown in Table 15.

In the given Table 15, we develop overall ranking through the following formula:

$$\begin{bmatrix} W1 \\ W2 \\ Wn \end{bmatrix} * \begin{bmatrix} w11 & w12 & w1m \\ w21 & w22 & w2m \\ wm1 & wm2 & wmm \end{bmatrix} \quad (7)$$

where *m* presents the number of alternatives.

Table 5 Pair-wise decision matrix

Index	Criteria	Quality	Interactive	Accuracy	Efficiency	Performance	Flexibility	Accessible
1	Quality	1	3	2	½	4	5	3
2	Interactive	1/3	1	2	1/3	½	3	4
3	Accuracy	½	½	1	4	3	6	7
4	Efficiency	2	3	¼	1	5	7	2
5	Performance	¼	2	1/3	1/5	1	1/2	1/3
6	Flexibility	1/5	1/3	1/6	1/7	2	1	3
7	Accessible	1/3	¼	1/7	½	3	1/3	1

Table 6 Fuzzified pair-wise comparison matrix

Index	Criteria	Quality	Interactive	Accuracy	Efficiency	Performance	Flexibility	Accessible
1	Quality	(1, 1, 1)	(2, 3, 4)	(1, 2, 3)	(1/3, 1/2, 1/1)	(3, 4, 5)	(4, 5, 6)	(2, 3, 4)
2	Interactive	(1/4, 1/3, 1/2)	(1, 1, 1)	(1, 2, 3)	(1/4, 1/3, 1/2)	(1/3, 1/2, 1/1)	(2, 3, 4)	(3, 4, 5)
3	Accuracy	(1/3, 1/2, 1/1)	(1/3, 1/2, 1/1)	(1, 1, 1)	(3, 4, 5)	(2, 3, 4)	(5, 6, 7)	(6, 7, 8)
4	Efficiency	(1, 2, 3)	(2, 3, 4)	(1/5, 1/4, 1/3)	(1, 1, 1)	(4, 5, 6)	(6, 7, 8)	(1, 2, 3)
5	Performance	(1/5, 1/4, 1/3)	(1, 2, 3)	(1/4, 1/3, 1/2)	(1/6, 1/5, 1/4)	(1, 1, 1)	(1/3, 1/2, 1/1)	(1/4, 1/3, 1/2)
6	Flexibility	(1/6, 1/5, 1/4)	(1/4, 1/3, 1/2)	(1/7, 1/6, 1/5)	(1/8, 1/7, 1/6)	(1, 2, 3)	(1, 1, 1)	(2, 3, 4)
7	Accessible	(1/4, 1/3, 1/2)	(1/5, 1/4, 1/3)	(1/8, 1/7, 1/6)	(1/3, 1/2, 1/1)	(2, 3, 4)	(1/4, 1/3, 1/2)	(1, 1, 1)

Table 7 Fuzzy geometric mean value

Index	Criteria	Quality	Interactive	Accuracy	Efficiency	Performance	Flexibility	Accessible	Fuzzy Geometric Value (r_i)
1	Quality	(1, 1, 1)	(2, 3, 4)	(1, 2, 3)	(1/3, 1/2, 1/1)	(3, 4, 5)	(4, 5, 6)	(2, 3, 4)	(1.47, 2.07, 2.77)
2	Interactive	(1/4, 1/3, 1/2)	(1, 1, 1)	(1, 2, 3)	(1/4, 1/3, 1/2)	(1/3, 1/2, 1/1)	(2, 3, 4)	(3, 4, 5)	(0.75, 1.04, 1.46)
3	Accuracy	(1/3, 1/2, 1/1)	(1/3, 1/2, 1/1)	(1, 1, 1)	(3, 4, 5)	(2, 3, 4)	(5, 6, 7)	(6, 7, 8)	(1.52, 1.99, 2.67)
4	Efficiency	(1, 2, 3)	(2, 3, 4)	(1/5, 1/4, 1/3)	(1, 1, 1)	(4, 5, 6)	(6, 7, 8)	(1, 2, 3)	(1.37, 1.92, 2.43)
5	Performance	(1/5, 1/4, 1/3)	(1, 2, 3)	(1/4, 1/3, 1/2)	(1/6, 1/5, 1/4)	(1, 1, 1)	(1/3, 1/2, 1/1)	(1/4, 1/3, 1/2)	(0.36, 0.48, 0.68)
6	Flexibility	(1/6, 1/5, 1/4)	(1/4, 1/3, 1/2)	(1/7, 1/6, 1/5)	(1/8, 1/7, 1/6)	(1, 2, 3)	(1, 1, 1)	(2, 3, 4)	(0.39, 0.52, 0.65)
7	Accessible	(1/4, 1/3, 1/2)	(1/5, 1/4, 1/3)	(1/8, 1/7, 1/6)	(1/3, 1/2, 1/1)	(2, 3, 4)	(1/4, 1/3, 1/2)	(1, 1, 1)	(0.38, 0.49, 0.66)

On the basis of above equation, we calculate the results of each method. After calculation of results, we rank the methods as shown in Table 16.

Figure 3 shows the ranking of each alternative. By using these figures, we easily identified the rank of alternatives.

4 Results and discussion

The traditional teaching methods are broken due to the COVID-19 epidemic and transform education to online mode which make the education easy and efficient all over the world. Online teaching method can improve the

Table 8 Criterion fuzzy weights, weights and ranking using geometric mean method

Index	Criteria	Fuzzy geometric value (r_i)	Fuzzy weights (W_i)	Weights (w_i)	Normalized weights	Ranking
1	Quality	(1.47, 2.07, 2.77)	(0.129, 0.242, 0.443)	0.271	0.242	1
2	Interactive	(0.75, 1.04, 1.46)	(0.066, 0.122, 0.234)	0.141	0.126	4
3	Accuracy	(1.52, 1.99, 2.67)	(0.134, 0.233, 0.427)	0.265	0.237	2
4	Efficiency	(1.37, 1.92, 2.43)	(0.121, 0.225, 0.389)	0.245	0.219	3
5	Performance	(0.36, 0.48, 0.68)	(0.032, 0.056, 0.109)	0.065	0.058	6
6	Flexibility	(0.39, 0.52, 0.65)	(0.034, 0.061, 0.104)	0.066	0.059	5
7	Accessible	(0.38, 0.49, 0.66)	(0.033, 0.057, 0.106)	0.065	0.058	6

Fig. 2 Criterion weightage and ranking
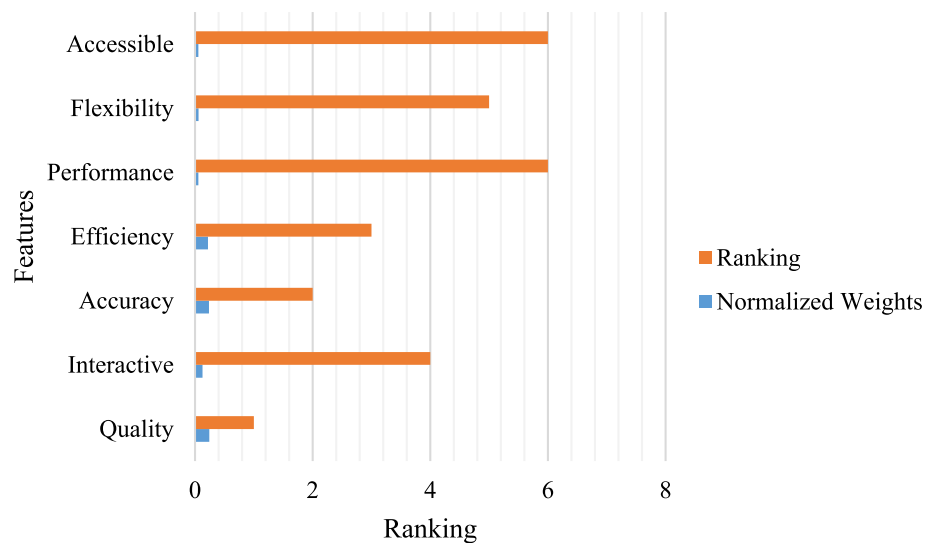
Table 9 Alternatives pair-wise comparison matrix based on quality criteria

Quality	Method 1	Method 2	Method 3	Method 4	Fuzzy geometric value (r_i)	Fuzzy weights	Weights (W_i)	Normalized Weights (W_i)
Method 1	(1, 1, 1)	(5, 6, 7)	(3, 4, 5)	(7, 8, 9)	(3.20, 3.72, 4.21)	(0.457, 0.632, 0.871)	0.653	0.627
Method 2	(1/7, 1/6, 1/5)	(1, 1, 1)	(1/3, 1/2, 1/1)	(2, 3, 4)	(0.55, 0.69, 0.94)	(0.078, 0.117, 0.194)	0.129	0.124
Method 3	(1/5, 1/4, 1/3)	(1, 2, 3)	(1, 1, 1)	(2, 3, 4)	(0.79, 1.10, 1.41)	(0.112, 0.187, 0.291)	0.196	0.188
Method 4	(1/9, 1/8, 1/7)	(1/4, 1/3, 1/2)	(1/4, 1/3, 1/2)	(1, 1, 1)	(0.28, 0.34, 0.43)	(0.040, 0.057, 0.089)	0.062	0.059

education and have positive impact on the student learning. The selection process of teaching is very complicated when different methods are available. To overcome this problem, we used Fuzzy AHP method to select best teaching method and solve the decision issue. This method is easy to use for the identification of best method. In this study, first we define the goal, criteria and alternatives. By applying the Fuzzy AHP method, we identify the weightage of each criteria and compare the alternatives based on criterion to rank them for decision purpose. From the weightage values of criterions, we concluded that quality has high importance with a value of 0.242 followed by accuracy with a value of 0.237, efficiency with a value of 0.219, interactive with a value of 0.126, flexibility with a value of 0.059 and

Table 10 Alternatives pair-wise comparison matrix based on interactive criteria

Interactive	Method 1	Method 2	Method 3	Method 4	Fuzzy geometric value (r_i)	Fuzzy weights	Weights (W_i)	Normalized weights (W_i)
Method 1	(1, 1, 1)	(4, 5, 6)	(6, 7, 8)	(1, 2, 3)	(2.21, 2.89, 3.46)	0.349, 0.554, 0.837	0.58	0.550
Method 2	(1/6, 1/5, 1/4)	(1, 1, 1)	(1/8, 1/7, 1/6)	(2, 3, 4)	(0.44, 0.53, 0.63)	0.069, 0.101, 0.152	0.107	0.101
Method 3	(1/8, 1/7, 1/6)	(6, 7, 8)	(1, 1, 1)	(2, 3, 4)	(1.10, 1.30, 1.50)	0.173, 0.249, 0.363	0.261	0.247
Method 4	(1/3, 1/2, 1/1)	(1/4, 1/3, 1/2)	(1/4, 1/3, 1/2)	(1, 1, 1)	(0.37, 0.48, 0.70)	0.058, 0.092, 0.169	0.106	0.101

Table 11 Alternatives Pair-wise Comparison Matrix based on Accuracy Criteria

Accuracy	Method 1	Method 2	Method 3	Method 4	Fuzzy geometric value (r_i)	Fuzzy weights	Weights (W_i)	Normalized weights (W_i)
Method 1	(1, 1, 1)	(4, 5, 6)	(2, 3, 4)	(6, 7, 8)	(2.63, 3.20, 3.72)	(0.389, 0.582, 0.848)	0.606	0.572
Method 2	(1/6, 1/5, 1/4)	(1, 1, 1)	(1/3, 1/2, 1/1)	(3, 4, 5)	(0.63, 0.79, 1.05)	(0.093, 0.143, 0.239)	0.158	0.149
Method 3	(1/4, 1/3, 1/2)	(1, 2, 3)	(1, 1, 1)	(2, 3, 4)	(0.84, 1.18, 1.56)	(0.124, 0.214, 0.355)	0.231	0.218
Method 4	(1/8, 1/7, 1/6)	(1/5, 1/4, 1/3)	(1/4, 1/3, 1/2)	(1, 1, 1)	(0.28, 0.32, 0.40)	(0.041, 0.058, 0.091)	0.063	0.059

Table 12 Alternatives pair-wise comparison matrix based on efficiency criteria

Efficiency	Method 1	Method 2	Method 3	Method 4	Fuzzy geometric value (r_i)	Fuzzy weights	Weights (W_i)	Normalized weights (W_i)
Method 1	(1, 1, 1)	(2, 3, 4)	(3, 4, 5)	(6, 7, 8)	(2.44, 3.02, 3.55)	(0.375, 0.570, 0.852)	0.599	0.565
Method 2	(1/4, 1/3, 1/2)	(1, 1, 1)	(1, 2, 3)	(2, 3, 4)	(0.84, 1.18, 1.56)	(0.129, 0.223, 0.374)	0.242	0.228
Method 3	(1/5, 1/4, 1/3)	(1/3, 1/2, 1/1)	(1, 1, 1)	(1/5, 1/4, 1/3)	(0.33, 0.42, 0.57)	(0.050, 0.079, 0.136)	0.088	0.083
Method 4	(1/8, 1/7, 1/6)	(1/4, 1/3, 1/2)	(3, 4, 5)	(1, 1, 1)	(0.55, 0.65, 0.79)	(0.084, 0.122, 0.189)	0.131	0.123

the last two are performance and accessible with the same value of 0.058. Finally, in order to select best method, we calculate weightage of each alternative and rank them. The result shows that the method 1 is the best method with a value of 0.56 (rank 1) followed by method 3 with a value of 0.184 (rank 2), method 2 with a value of 0.154 (rank 3) and method 4 is worst method with a value of 0.085(rank 4) as shown in Fig. 3. In order to decide the best method, the Fuzzy AHP method plays an efficient and effective role.

Figure 4 shows the alternatives weightage based on each criterion and also ranking of each alternative.

Figure 5 shows the calculated weightage and ranking of each criterion.

Table 13 Alternatives pair-wise comparison matrix based on performance criteria

Performance	Method 1	Method 2	Method 3	Method 4	Fuzzy geometric value (r_i)	Fuzzy weights	Weights (W_i)	Normalized Weights (W_i)
Method 1	(1, 1, 1)	(4, 5, 6)	(3, 4, 5)	(1, 2, 3)	(1.86, 2.51, 3.08)	(0.293, 0.484, 0.745)	0.507	0.480
Method 2	(1/6, 1/5, 1/4)	(1, 1, 1)	(1/6, 1/5, 1/4)	(2, 3, 4)	(0.47, 0.58, 0.70)	(0.074, 0.111, 0.169)	0.118	0.111
Method 3	(1/5, 1/4, 1/3)	(4, 5, 6)	(1, 1, 1)	(6, 7, 8)	(1.48, 1.71, 1.99)	(0.233, 0.330, 0.481)	0.348	0.329
Method 4	(1/3, 1/2, 1/1)	(1/4, 1/3, 1/2)	(1/8, 1/7, 1/6)	(1, 1, 1)	(0.31, 0.38, 0.53)	(0.048, 0.073, 0.128)	0.083	0.078

Table 14 Alternatives pair-wise comparison matrix based on flexibility criteria

Flexibility	Method 1	Method 2	Method 3	Method 4	Fuzzy geometric value (r_i)	Fuzzy weights	Weights (W_i)	Normalized weights (W_i)
Method 1	(1, 1, 1)	(5, 6, 7)	(3, 4, 5)	(6, 7, 8)	(3.08, 3.60, 4.09)	(0.449, 0.626, 0.858)	0.644	0.621
Method 2	(1/7, 1/6, 1/5)	(1, 1, 1)	(1/3, 1/2, 1/1)	(1/4, 1/3, 1/2)	(0.32, 0.40, 0.56)	(0.046, 0.069, 0.117)	0.077	0.074
Method 3	(1/5, 1/4, 1/3)	(1, 2, 3)	(1, 1, 1)	(3, 4, 5)	(0.88, 1.18, 1.49)	(0.128, 0.205, 0.312)	0.215	0.207
Method 4	(1/8, 1/7, 1/6)	(2, 3, 4)	(1/5, 1/4, 1/3)	(1, 1, 1)	(0.47, 0.56, 0.67)	(0.068, 0.097, 0.140)	0.101	0.097

Table 15 Alternatives pair-wise comparison matrix based on accessible criteria

Accessible	Method 1	Method 2	Method 3	Method 4	Fuzzy geometric value (r_i)	Fuzzy weights	Weights (W_i)	Normalized weights (W_i)
Method 1	(1, 1, 1)	(4, 5, 6)	(2, 3, 4)	(1/5, 1/4, 1/3)	(1.12, 1.39, 1.67)	(0.217, 0.330, 0.490)	0.345	0.328
Method 2	(1/6, 1/5, 1/4)	(1, 1, 1)	(5, 6, 7)	(2, 3, 4)	(1.12, 1.37, 1.62)	(0.217, 0.326, 0.476)	0.339	0.322
Method 3	(1/4, 1/3, 1/2)	(1/7, 1/6, 1/5)	(1, 1, 1)	(2, 3, 4)	(0.51, 0.63, 0.79)	(0.098, 0.149, 0.232)	0.159	0.151
Method 4	(3, 4, 5)	(1/4, 1/3, 1/2)	(1/4, 1/3, 1/2)	(1, 1, 1)	(0.65, 0.81, 1.05)	(0.126, 0.192, 0.308)	0.208	0.197

Table 16 Fuzzy AHP Using Geometric Mean Method Results for Ranking Alternatives

Criteria alternatives	Quality	Interactive	Accuracy	Efficiency	Performance	Flexibility	Accessible	Results	Rankings
Criteria Weights	0.242	0.126	0.237	0.219	0.058	0.059	0.058		
Method 1	0.627	0.550	0.572	0.565	0.480	0.621	0.328	0.56	1
Method 2	0.124	0.101	0.149	0.228	0.111	0.074	0.322	0.154	3
Method 3	0.188	0.247	0.218	0.083	0.329	0.207	0.151	0.184	2
Method 4	0.059	0.101	0.059	0.123	0.078	0.097	0.197	0.085	4

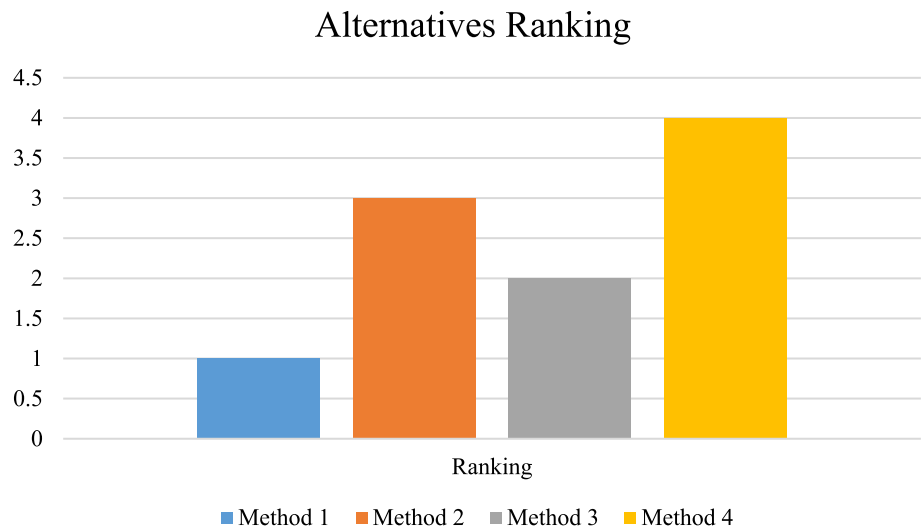**Fig. 3** Ranking of alternatives

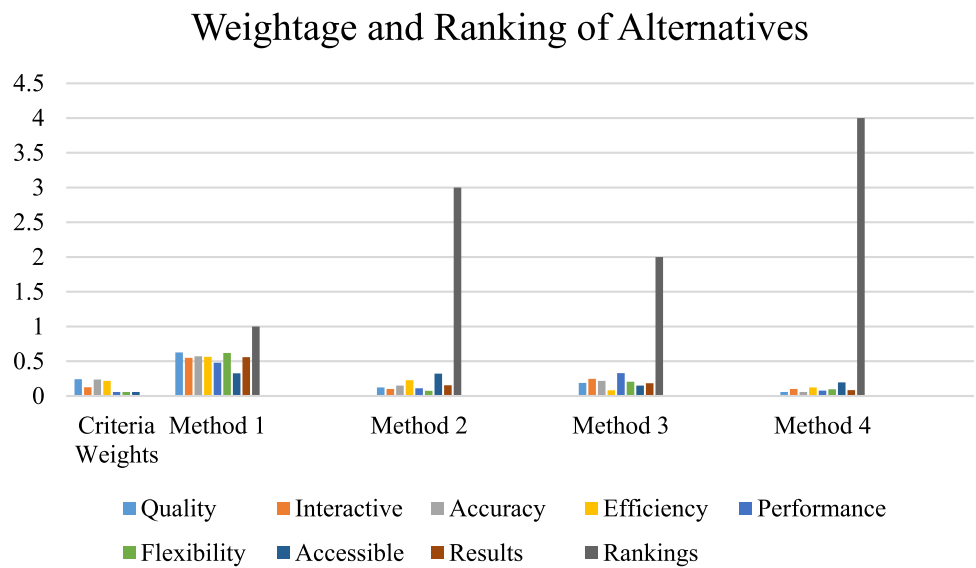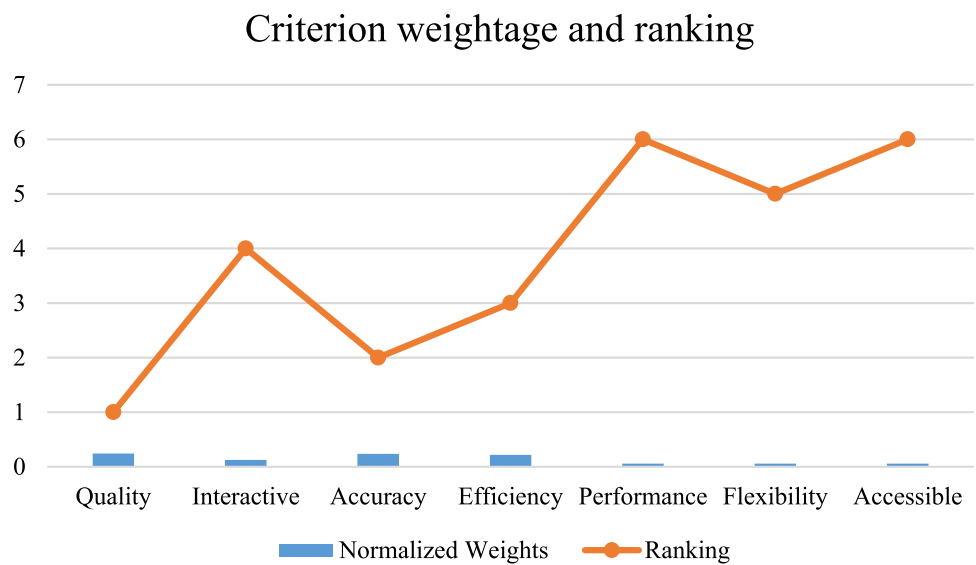
Fig. 4 Alternatives weightage and ranking

Fig. 5 Weights and ranking of criterions

5 Conclusion

Traditional teaching methods have been shattered due to social alienation and school closures all around the world as a result of the COVID-19 pandemic. While the Internet and education have become perfect topics to enhance the teaching mode during an epidemic to help students, teachers, and institutes for a better learning process, during the epidemic, information technology solved and improved the students' and teachers' issues of learning through the online teaching mode, and the COVID-19 pandemic has exposed several issues in online teaching that were faced by tutors and students during the classes. During the COVID-19 pandemic, online education played a critical role in spreading education over the world. Correct recognition of learners' education modes in virtual teaching of ideological and political teaching processes is beneficial to improving learners' focus in the education mechanism and the impact of online teaching of ideological and political teaching. Because of the rapid advancement of computer technology, big data technology is now being used more widely in the teaching of ideological and political philosophy. Because of the COVID-19 outbreak, the abrupt switch from traditional to online instruction has created various issues. During an epidemic, online instruction improves the learning process and has a good impact on students' learning.

Declaration

Conflict of interest The authors declare that there is no conflict of interest regarding this paper.

Ethical approval The paper does not deal with any ethical problems.

Informed consent We declare that all the authors have informed consent.

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