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PAPER

Achieving Optimal Decision Making in Mobile English Language Teaching Using Information Technology

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ABSTRACT

In the context of globalization, the quality and effectiveness of English education have become increasingly significant. The rapid advancement of information technology has provided a wealth of tools and methods for enhancing English education. However, achieving optimal decision-making in the context of information technology to improve the overall efficiency of English education remains a pressing issue. Network data envelopment analysis (network DEA), an effective performance evaluation tool, systematically analyzes and optimizes complex multi-stage decision processes, thereby providing scientific support for educational decision-making. Although numerous studies have attempted to incorporate information technology into educational decision-making, most methods focus on single-stage processes and lack systematic analysis of the entire decision process. This study constructs and designs a decision process model for mobile English education based on network DEA, systematically analyzing the input-output relationships at each stage and proposing optimization strategies and implementation plans to achieve optimal educational decisions. This study not only addresses the shortcomings of existing methods by providing more comprehensive and scientific decision support but also offers crucial references for educational administrators in formulating and implementing effective teaching strategies in the context of information technology.

KEYWORDS

information technology, English education, optimal decision-making, network data envelopment analysis (network DEA), performance evaluation, decision process model, teaching effectiveness, optimization strategies

1 INTRODUCTION

In the era of deepening globalization, the quality and effectiveness of English education have become increasingly significant as English serves as a universal language. The rapid development of information technology has led to the emergence of various online learning platforms and digital teaching resources, providing a wealth of tools and means for English education [1–4]. However, how to

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achieve optimal decision-making in these information technology environments to enhance the overall efficiency of English education has become a focal point for educators and researchers [5, 6]. Network data envelopment analysis (network DEA), as an effective performance evaluation tool, can systematically analyze and optimize complex multi-stage decision processes, providing scientific evidence for educational decision-making.

Utilizing information technology to optimize English education decision-making cannot only enhance students' learning experience and satisfaction but also significantly improve the efficiency of teaching resources and educational outcomes [7–9]. By constructing and designing a decision process model based on network DEA, a comprehensive analysis of the input-output relationships at each stage can be conducted, identifying key factors influencing educational effectiveness and providing precise decision support for educational administrators [10, 11]. This research is not only theoretically significant but also offers practical guidance for teaching management, promoting continuous improvement and innovation in English education.

Although numerous studies have attempted to integrate information technology into educational decision-making, most methods have focused on single stages or specific aspects, lacking systematic analysis of the entire decision process [12–15]. Additionally, traditional performance evaluation methods often overlook the interactions between different stages, making it challenging to comprehensively measure the overall effectiveness of educational decisions [16, 17]. Especially in the field of English education, existing methods frequently struggle to address complex multi-stage, multi-criteria decision problems effectively, failing to provide optimal strategies [18].

The main research content of this study is divided into two parts: Firstly, a decision-process model for mobile English education based on network DEA was constructed, systematically analyzing the input-output relationships at each stage and identifying key influencing factors. Secondly, a decision process model based on network DEA was designed, and optimization strategies and implementation plans were proposed to achieve optimal educational decisions. This study aims to address the deficiencies of existing methods by providing more comprehensive and scientific decision support and offering crucial references for educational administrators in formulating and implementing effective teaching strategies in the context of information technology, thereby significantly enhancing the overall quality and efficiency of English education.

2 CONSTRUCTION OF A DECISION PROCESS MODEL IN MOBILE ENGLISH EDUCATION BASED ON NETWORK DEA

2.1 Analysis of model structure

Drawing on the five-stage decision process theory in the Engel model, the decision process in a mobile English education environment was divided into five interconnected subsystems: educational stimuli, motivation determination, scheme evaluation, decision-making, and subsequent behavior. Educational stimuli refer to various external factors influencing learners, including educational resources, teaching methods, and learning environments. Motivation determination involves learners forming intrinsic motivations and needs for English learning based on educational stimuli. Following this is scheme evaluation, where learners assess different English learning schemes according to their motivations and external conditions, such as course selection, learning paths, and tutoring institutions. The fourth stage is decision-making, where learners make specific learning choices, such as enrolling in a course or attending a training session, after considering various factors comprehensively. Finally, subsequent behavior involves learners' actual learning actions and feedback after implementing the decision, which, in turn, affects the preceding subsystems.

Based on the interrelationships of the aforementioned five subsystems, a matrix-type network DEA model was constructed to analyze and optimize the decision process in a mobile English education environment. This model can evaluate the efficiency and relative effectiveness of each subsystem through input-output analysis, identify key factors affecting decision outcomes, and suggest improvements. Through the information processing of this model, the influence of educational stimuli on motivation determination can be analyzed to optimize the allocation of educational resources. The effectiveness of different learning schemes can be assessed to optimize course design. Teaching methods and learning support systems can be improved based on feedback from subsequent behavior.

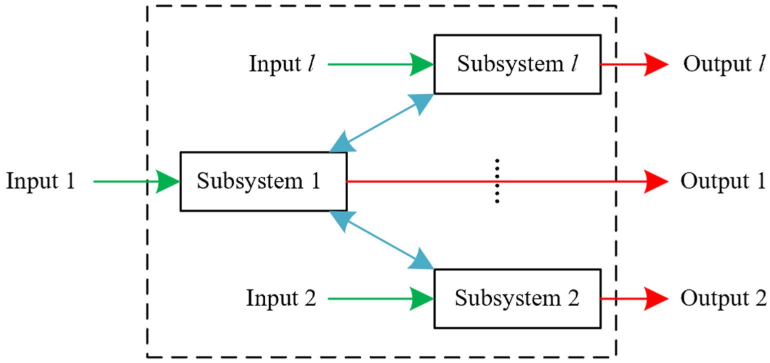

Fig. 1. Abstract matrix network structure of the decision process in mobile English education

To facilitate intuitive presentation, the network model was simplified in this study by defining three subsystems: educational stimuli, motivation determination, and scheme evaluation. An abstract matrix network structure diagram of the decision process can be drawn to demonstrate the input-output relationships between these subsystems. Figure 1 illustrates the abstract matrix network structure of the decision process in a mobile English education environment.

2.2 Construction of individual subsystems

The external inputs and outputs of each decision unit representing an English learner were defined in this study. External inputs may include teaching resources, learning time, and teacher guidance, while external outputs may comprise academic performance and improvements in language proficiency. Internal inputs and outputs represent the interactions between subsystems. Specifically, suppose there are l decision units, each with v subsystems. The external input of decision unit FLI_{k0} is denoted by a_{k0}, and the external output of FLI_{k0} is denoted by b_{k0}. The internal input of FLI_{k0} from subsystem t_j (where $j = 1, 2, \ldots l$ and $j \neq m$) to subsystem t_m within the decision unit is denoted by $c_{k0}^{(j,m)}$ (where $j = 1, 2, \ldots l$ and $j \neq m$). Similarly, the internal output of FLI_{k0} from subsystem t_m (where $j = 1, 2, \ldots l$ and $j \neq m$) to subsystem t_j within the decision unit is denoted by $c_{k0}^{(m,j)}$ (where $j = 1, 2, \ldots l$ and $j \neq m$).

On this basis, the efficiency of each subsystem can be calculated. Suppose the efficiency of the motivation determination subsystem is being evaluated. The external stimuli received for learning motivation and their impact on scheme evaluation should be considered, thereby determining the contribution and efficiency of each subsystem in the overall decision process. The following formula provides the efficiency calculation for the m-th subsystem of the decision unit FLI_{k0}:

$$\begin{aligned} &o.b. \quad MAX\Omega_m = \frac{i_m b_0^m + \sum_{\substack{j=1 \\ j\neq l}}^{l} \varsigma_{mj} c_0^{(m.j)}}{n_m b_0^m + \sum_{\substack{j=1 \\ j\neq l}}^{l} \zeta_{jm} c_0^{(m.j)}} \\ &s.t. \quad \frac{i_m b_k^m + \sum_{\substack{j=1 \\ j\neq l}}^{l} \varsigma_{mj} c_k^{(m.j)}}{n_m b_k^m + \sum_{\substack{j=1 \\ j\neq l}}^{l} \zeta_{jm} c_k^{(j.m)}} \le 1, k = 1, 2, \ldots l \\ &i_m, n_m, \varsigma_{mj}, \zeta_{jm} \ge 0, j = 1, 2, \ldots l \end{aligned} \tag{1}$$

The intermediate inputs and outputs in the default model are assumed to be balanced, as represented by the equation:

$$\sum_{\substack{j=1 \\ j\neq m}}^{l} \zeta_{jm} c_k^{(j,m)} = \sum_{\substack{j=1 \\ j\neq m}}^{l} \varsigma_{mj} c_k^{(m,j)} \tag{2}$$

To ensure the accuracy and scientific validity of the model, linear transformations and optimizations were applied to Equation (1), resulting in the optimal value for each subsystem:

$$\begin{aligned} &o.b. \quad MAX\Omega^m = \frac{i_m b_0^m + \sum_{\substack{j=1 \\ j\neq m}}^{l} \varsigma_{mj} c_0^{(m.j)}}{n_m b_0^m + \sum_{\substack{j=1 \\ j\neq m}}^{l} \varsigma_{jm} c_0^{(j.m)}} \\ &s.t. \quad \frac{i_m b_k^m + \sum_{\substack{j=1 \\ j\neq m}}^{l} \varsigma_{mj} c_k^{(m.j)}}{n_m b_k^m + \sum_{\substack{j=1 \\ j\neq m}}^{l} \varsigma_{jm} c_k^{(j.m)}} \le 1, j = 1, 2, \ldots n \\ &i_m, n_m, \varsigma_{mj} \ge 0, j = 1, 2, \ldots l, j \neq m \end{aligned} \tag{3}$$

If the optimal value Ω^{m*} of a subsystem equals 1, the subsystem t_m (where $m = 1, 2, \ldots l$) is considered to be weakly DEA efficient, indicating that the subsystem's efficiency is maximized under the current input and output conditions. If the optimal value Ω^{m*} equals 1 and all related weights are greater than 0, i.e., $\omega_m^*, \mu_m^* > 0$ (where $j = 1, 2, \ldots l$ and $j \neq m$), the subsystem t_m (where $m = 1, 2, \ldots l$) is deemed to be

DEA efficient, signifying that it is optimal among all decision units. Figure 2 shows the structure of the *m*-th subsystem.

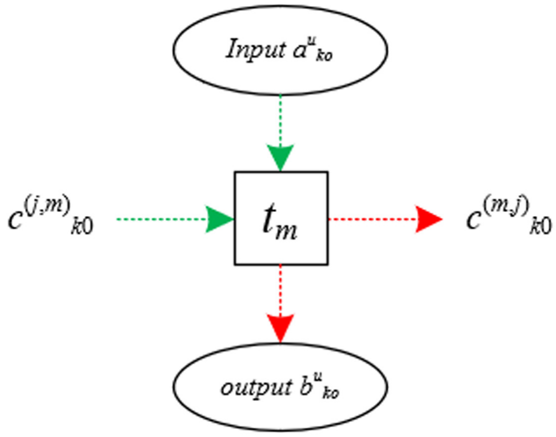

Fig. 2. Structure of the *m*-th subsystem

2.3 Overall model construction

To achieve a comprehensive evaluation of decision-making in a mobile English education environment, this study adopts the weighting concept and utilizes the allocation weights of inputs as the weights for each subsystem. Specifically, each subsystem is assigned different weights based on its relative importance in the entire decision process, ensuring that the final efficiency evaluation is more objective and comprehensive. For instance, the teaching methods employed by educators might significantly impact students' learning outcomes. Therefore, a higher weight would be assigned to this subsystem within the model.

$$
\begin{aligned}
&o.b. \quad MAX\Theta = \sum_{m=1}^{l} \beta_m \Omega^m \\
&s.t. \quad \frac{i_m b_k^m + \sum_{\substack{j=1 \\ j\neq m}}^{l} \varsigma_{mj} c_j^{(m,j)}}{n_m b_k^m + \sum_{\substack{j=1 \\ j\neq m}}^{l} \varsigma_{jm} c_j^{(j,m)}} \le 1, k = 1,2,\ldots v; m = 1,2,\ldots l \\
&i_m, n_m, \varsigma_{mj} \ge 0, m = 1,2,\ldots l; j = 1,2,\ldots l; j \neq m
\end{aligned}
\tag{4}
$$

where,

$$
\beta_m = \frac{n_m b_k^m + \sum_{\substack{j=1 \\ j\neq m}}^{l} \varsigma_{jm} c_j^{(j,m)}}{\sum_{m=1}^{l}\left(n_m b_k^m + \sum_{\substack{j=1 \\ j\neq m}}^{l} \varsigma_{jm} c_j^{(j,m)} \right)} > 0
$$

The linearization process facilitates the solution of the model, allowing complex nonlinear problems to be addressed through linear programming methods. Subsequently, the Charnes-Cooper (CC) transformation method was applied to linearize and simplify the model. This step is crucial for enhancing the computational efficiency and operability of the model. Assuming the relative importance of the outputs between subsystems is denoted by ω_m, the relative importance of inputs between subsystems is represented by μ_m, and the relative importance of various outputs at this stage is indicated by λ_{mj}, it follows that:

$$
\begin{aligned}
&o.b. \quad MAX\Theta = \sum_{m=1}^{l}\left(\omega_m b_0^m + \sum_{\substack{j=1\\ j\neq m}}^{l} \lambda_{mj} c_0^{(m,j)}\right) \\
&s.t. \quad \sum_{m=1}^{l}\left(\omega_m b_0^m + \sum_{\substack{j=1\\ j\neq m}}^{l} \lambda_{jm} c_0^{(j,m)}\right) = 1 \\
&\omega_m b_k^m + + \sum_{\substack{j=1\\ j\neq m}}^{l} \lambda_{mj} c_k^{(m,j)} \le \mu_m a_k^m + \sum_{\substack{j=1\\ j\neq m}}^{l} \lambda_{jm} c_k^{(j,m)} \quad k = 1,2,\ldots v; m = 1,2,\ldots l \\
&\omega_m, \mu_m, \lambda_{mj} \ge 0 \quad m = 1,2,\ldots l; j = 1,2,\ldots l, j \neq m
\end{aligned} \tag{5}
$$

In the solution process, the decision unit FLI_{k0} (where $k_0 \in \{1, 2, \ldots v\}$) is considered DEA efficient if and only if the optimal value of Θ is 1, and the weights ω_m^* and μ_m^* for each subsystem are greater than 0. This indicates that the decision unit has achieved optimal status in the input-output relationships across all subsystems. If only $\Theta^* = 1$ is considered, without regard to the weights being positive or negative, the decision unit is considered weakly DEA efficient, indicating relatively good overall efficiency but not necessarily optimal.

To further optimize and validate the model, the dual model was solved in this study for analysis. The dual model provides an alternative perspective to examine the solutions of the original model and can help identify potential areas for improvement and strategies.

$$
\begin{aligned}
&s.t. \quad \sum_{u=1}^{v} a_k^m \eta_k^m \le \varphi a_0^m, m = 1,2,\ldots l \\
&\sum_{u=1}^{v} b_k^m \eta_k^m \ge b_0^m, m = 1,2,\ldots l \\
&\sum_{u=1}^{v} c_k^{(j,m)} \eta_k^m - \sum_{u=1}^{v} c_k^{(j,m)} \eta_k^j \le \varphi c_0^{(j,m)} - c_0^{(j,m)} \\
&m = 1,2,\ldots l, j = 1,2,\ldots l, j \neq m \\
&\eta_k^m \ge 0, m = 1,2,\ldots l, k = 1,2,\ldots v
\end{aligned} \tag{6}
$$

At that point, the matrix-type network DEA model for decision-making in a mobile English education environment was completed. The above two equations constitute the matrix-type network DEA model.

3 DESIGN OF THE DECISION PROCESS MODEL FOR MOBILE ENGLISH EDUCATION BASED ON NETWORK DEA

3.1 Determination of English teaching decision types

When constructing a decision process model for mobile English education based on Network DEA, it is crucial to select appropriate types of English teaching decisions, as it directly affects the model's relevance and applicability. Firstly, the diversity and flexibility of English teaching methods are central to the decision-making process in a mobile English education environment. Traditional classroom teaching, online learning, and blended learning models are widely applied and representative of university students' English learning. The design and selection of course content is at the core of English teaching decisions. University students' needs for course content are diverse, covering fundamental English, academic English, and professional English. Due to the broad and varied nature of course content, students must consider their learning goals and future career development, making their decisions more rational and targeted. The allocation and utilization of learning resources, including textbooks, online resources, and learning software, are also critical decision types. The effective allocation of these resources directly impacts students' learning outcomes and efficiency. Evaluation and feedback mechanisms are essential components of English education decisions. Continuous feedback is necessary for students to adjust their learning strategies, and the effectiveness of evaluation mechanisms directly influences learning outcomes. Figure 3 shows the network mathematical model of the decision process in a mobile English education environment.

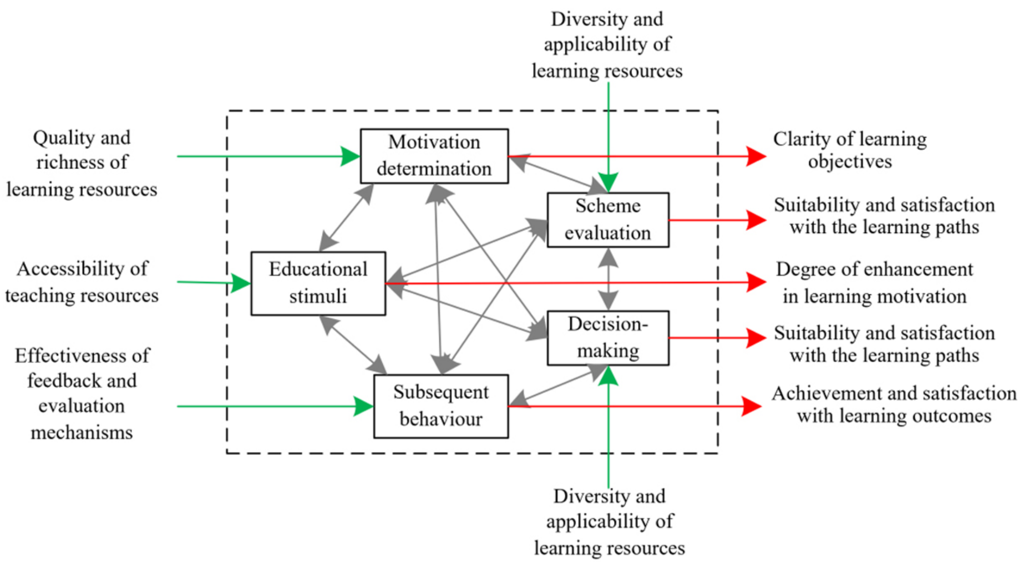

Fig. 3. Network mathematical model of the decision process in mobile English education

3.2 Selection of the indicator system

Referring to the research methods of the consumer decision process, this study proposes corresponding input and output indicators according to the model's subsystems to systematically analyze and optimize the allocation of educational resources and teaching strategies.

1. Input indicators
   a) The external input indicator for the educational stimuli subsystem is the accessibility of teaching resources. The core of this subsystem is to convey the importance and enjoyment of English learning to students through various channels, such as online courses, learning platforms, and social media.

Specific measurement indicators can include the frequency and breadth of students' exposure to English learning resources. This information can be collected through questionnaires and platform data. A five-point Likert scale can be used to assess students' exposure and interest levels in these resources.

   b) The external input indicator for the motivation determination subsystem is the quality and richness of learning resources. In this subsystem, students need to preliminarily understand and select different types of English learning resources to determine specific learning goals. Measurement indicators include the time and effort students spend choosing learning resources.
   c) The external input indicator for the scheme evaluation and decision-making subsystems is the diversity and applicability of learning resources. In this subsystem, students compare different learning paths, such as self-study, course learning, and tutoring classes, and ultimately choose the most suitable method. Specific measurement indicators include the time students spend selecting learning paths and their comparative evaluations of different paths.
   d) The external input indicator for the subsequent behavior subsystem is the effectiveness of feedback and evaluation mechanisms. In this subsystem, students need to test their learning outcomes through various evaluation mechanisms, such as quizzes, assignments, and class performance, and receive feedback to improve their learning strategies. Measurement indicators include the time and effort students spend receiving feedback and conducting self-evaluation.
2. Output indicators
   a) The external output indicator for the educational stimuli subsystem is the degree of enhancement in learning motivation. The core objective of this subsystem is to stimulate students' interest and motivation in learning English through various channels. Specific measurement indicators may include changes in students' interest and enthusiasm for learning English.
   b) The external output indicator for the motivation determination subsystem is the clarity of learning objectives. In this subsystem, students need to clarify and specify their learning objectives to formulate effective learning plans. Measurement indicators include students' evaluations of the clarity and specificity of their learning objectives.
   c) The external output indicator for the scheme evaluation and decision-making subsystems is the applicability and satisfaction with the learning paths. In this subsystem, students choose the most suitable learning path and evaluate it. Specific measurement indicators include students' evaluations of the applicability and satisfaction of different learning paths.
   d) The external output indicator for the subsequent behavior subsystem is achievement and satisfaction with learning outcomes. In this subsystem, students need to test their learning outcomes through various evaluation mechanisms and receive feedback to improve their learning strategies. Measurement indicators include students' evaluations of the achievement of learning outcomes and satisfaction with the evaluation mechanisms.
   e) The external output indicator for the entire decision process is the feeling of decision dissonance. The feeling of decision dissonance refers to the regret students feel about previous decisions made within a subsystem, reflecting the coherence and rationality of the decision process.

4 EXPERIMENTAL RESULTS AND ANALYSIS

Analysis of the distribution of decision quantities in the mobile English education environment, as shown in Figure 4, reveals significant differences across various stages. The diversity of teaching methods (193) and the flexibility of teaching methods (125) dominate the decision quantity, indicating that these factors are highly prioritized in the mobile English education environment. Course content design (98) and course content selection (42) also hold considerable importance, reflecting the central role of course content in educational decision-making. In contrast, learning resource allocation (22) and learning resource utilization (45) have relatively fewer decisions, suggesting that these areas may not have been fully utilized in current research and practice. Although the evaluation mechanism (25) and feedback mechanism (38) have fewer decisions, their importance cannot be overlooked, highlighting the emphasis on monitoring and feedback in mobile English education. The analysis results indicate that the diversity and flexibility of teaching methods are critical factors in optimizing the mobile English education environment. The significant differences in decision quantities further validate the importance of these factors in practical application. The design and selection of course content is essential for ensuring educational quality, and optimizing decisions in these areas can significantly enhance educational outcomes. Despite the lower decision quantities in learning resource allocation and utilization, their potential impact on teaching effectiveness should not be underestimated, indicating a need to further explore optimization strategies in future research. Although the evaluation and feedback mechanisms occupy a smaller proportion, their optimization as part of a closed-loop education system can play an essential role in achieving optimal educational decisions.

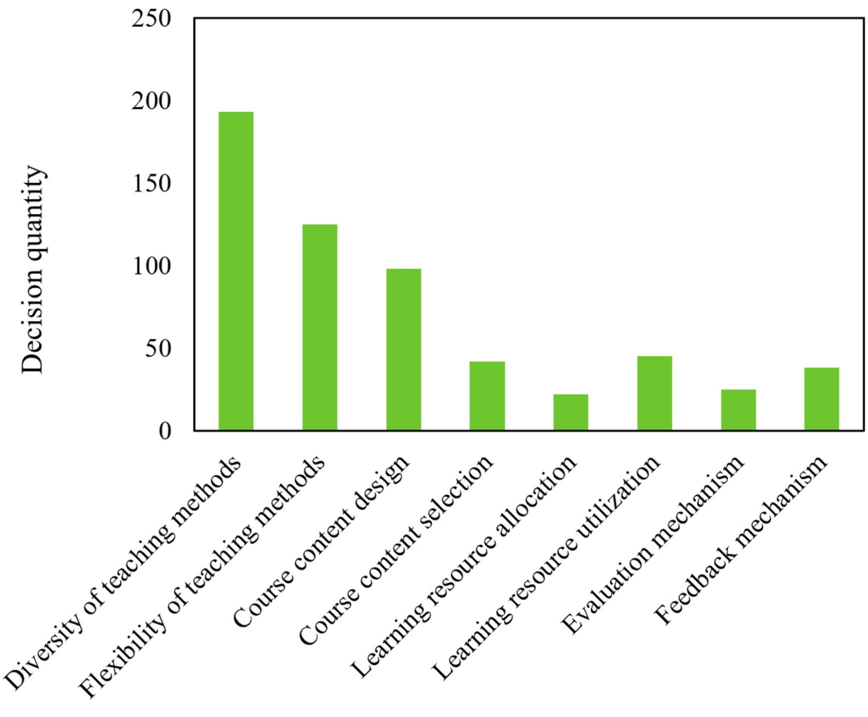

Fig. 4. Distribution of the number of different types of mobile English teaching decisions

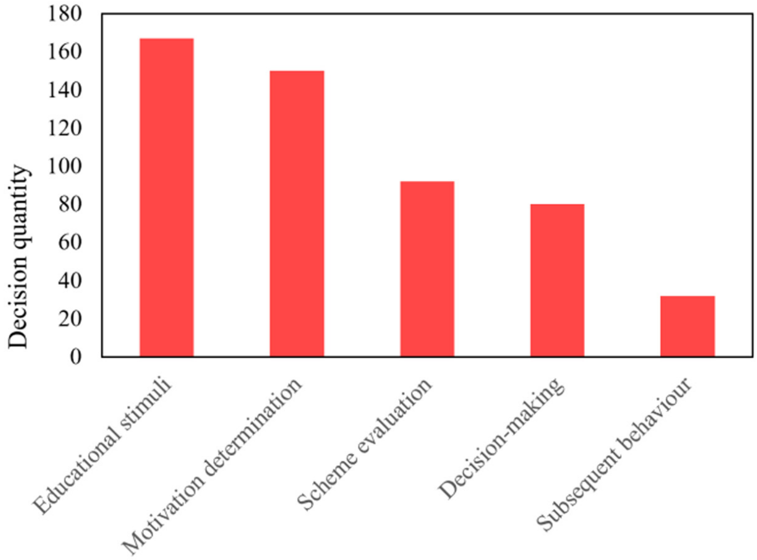

Fig. 5. Distribution of decision quantities in different subsystems of the mobile English education decision process

This study analyzes the decision subsystems within the mobile English education environment, revealing differences in decision quantities across subsystems. As shown in Figure 5, the educational stimuli (167) and motivation determination (150) subsystems occupy the top two positions in decision quantity, indicating that these stages receive extensive attention and frequent decision-making in mobile English education. While the scheme evaluation (92) and decision-making (80) subsystems also have a significant number of decisions, their decision quantities are fewer compared to those of educational stimuli and motivation determination, suggesting that these stages are secondary in the decision process. The subsequent behavior (32) subsystem has the fewest decisions, reflecting that this stage might not be adequately emphasized or that the complexity of decision-making is lower in the mobile English education environment. The analysis results indicate that educational stimuli and motivation determination are the most critical decision stages in mobile English education. The significant difference in decision quantities further validates the importance of these stages in enhancing learning outcomes. Although the scheme evaluation and decision-making stages have relatively fewer decisions, they play a crucial intermediary role in the overall decision process. Optimizing decisions in these stages is equally essential for achieving optimal educational outcomes. The fewest decisions in the subsequent behavior stage suggest that there may be insufficient attention to this stage in current research and practice, necessitating further exploration of optimization strategies in future studies.

Table 1. Overall efficiency distribution of different mobile English education decisions

Decision Efficiency Range	Number of Decisions	Percentage (%)	Overall Efficiency Mean
0.4–0.6	92	44.23	0.6245
0.6–0.8	100	48.69	
0.8–1.0	12	6.35	

Table 1 presents the overall efficiency distribution of mobile English education decisions. The number of decisions with an efficiency range between 0.4 and 0.6 is 92, accounting for 44.23%, indicating that nearly half of the decisions fall within a relatively low efficiency range. The number of decisions with an efficiency range between 0.6 and 0.8 is 100, making up 48.69% of the distribution, showing that most decisions fall within a medium efficiency range. The number of decisions with an efficiency range between 0.8 and 1.0 is only 12, accounting for 6.35%, reflecting that high-efficiency decisions constitute a small proportion of the overall number of decisions. Overall, the mean decision efficiency in mobile English education is 0.6245, indicating that the general decision efficiency is at a moderately low level. The analysis reveals that the majority of decision efficiencies in the mobile English education environment are concentrated in the low to medium range (0.4–0.8), highlighting significant room for optimization in the current decision process. The low proportion of high-efficiency decisions (0.8–1.0) suggests considerable challenges in achieving optimal educational decisions within the existing system.

Table 2. Distribution of decision efficiency in mobile English education with different content structures

Decision Efficiency Range		0–0.2	0.2–0.4	0.4–0.6	0.6–0.8	0.8–1.0	1	Efficiency Means
Systematic	Number of decisions	0	0	61	33	5	0	0.5895
Non-systematic	Number of decisions	0	0	28	69	8	0	0.66

Table 2 presents the distribution of decision efficiency in mobile English education environments with two different content structures: systematic and non-systematic. In the systematic environment, decision efficiency is concentrated in the 0.4–0.6 and 0.6–0.8 ranges, with 61 and 33 decisions, respectively, accounting for approximately 64.89% and 35.11%, with an efficiency mean of 0.5895. In the non-systematic environment, decision efficiency is mainly concentrated in the 0.6–0.8 range, with 69 decisions accounting for approximately 70.41%, followed by 28 decisions in the 0.4–0.6 range, accounting for approximately 28.57%, with an efficiency mean of 0.66. Comparatively, the non-systematic environment has a higher mean efficiency and a greater number of decisions in the high-efficiency range (0.8–1.0) than the systematic environment. The network DEA analysis results indicate that the non-systematic mobile English education environment outperforms the systematic environment in terms of decision efficiency, with mean efficiencies of 0.66 and 0.5895, respectively. This suggests that the non-systematic environment may be more flexible and better able to adapt to different learning needs and contexts, thereby improving decision efficiency. Nonetheless, the systematic environment ensures a certain degree of stability and consistency in decisions, even though the number of high-efficiency decisions is lower and its decision efficiency remains at a medium level.

Table 3. Distribution of decision efficiency in mobile English education with different interaction approaches

Decision Efficiency Range		0–0.2	0.2–0.4	0.4–0.6	0.6–0.8	0.8–1.0	1	Efficiency Mean
Course-oriented	Number of decisions	0	0	2	0	0	0	0.5489
Resource-oriented	Number of decisions	0	0	41	46	5	0	0.6231
Interaction-oriented	Number of decisions	0	0	32	27	5	0	0.6125
Support-oriented	Number of decisions	0	0	15	25	5	0	0.6458

Table 3 presents the distribution of decision efficiency in mobile English education environments with different interaction approaches. The decision efficiency for the course-oriented interaction approach is mainly concentrated in the 0.4–0.6 range, with 2 decisions and an efficiency mean of 0.5489. The resource-oriented interaction approach has a broader distribution of decision efficiency, primarily in the 0.4–0.6 and 0.6–0.8 ranges, with 41 and 46 decisions, respectively, and an efficiency mean of 0.6231. The interaction-oriented interaction approach also shows a concentration in the 0.4–0.6 and 0.6–0.8 ranges, with 32 and 27 decisions, respectively, and an efficiency mean of 0.6125. The support-oriented interaction approach performs best, with decision efficiency concentrated in the 0.6–0.8 range, comprising 25 decisions and an efficiency mean of 0.6458, the highest among all interaction approaches. The network DEA analysis results indicate significant differences in decision efficiency across different interaction approaches in mobile English education environments. The support-oriented interaction approach has the highest efficiency mean (0.6458), suggesting that it can more effectively support the learning process and improve decision efficiency. The resource-oriented and interaction-oriented interaction approaches also have relatively high efficiency means, at 0.6231 and 0.6125, respectively, indicating good decision efficiency in resource utilization and interaction. In contrast, the course-oriented interaction approach has the lowest efficiency mean (0.5489), possibly due to its excessive focus on course content, neglecting the flexibility of interaction and individual student needs.

5 CONCLUSION

This study primarily consists of two parts. First, a decision-process model for mobile English education environments was constructed based on the network DEA method. The input-output relationships at various stages were systematically analyzed, and key influencing factors were identified. This process included an analysis of the distribution of different types of mobile English teaching decisions, the distribution of decisions in different decision subsystems, the overall decision efficiency distribution, and the decision efficiency distribution across different content structures, interaction approaches, and application scenarios. Second, the decision process model based on network DEA was designed and applied, and optimization strategies and implementation plans were proposed to achieve optimal educational decisions. The study revealed the complex interactions among the decision subsystems in mobile English education environments through systematic network DEA analysis and proposed effective optimization strategies. The experimental results demonstrated significant differences in decision efficiency across different types, content structures, interaction approaches, and application scenarios of mobile English education. Moreover, the interactions and synergies among the optimized decision subsystems were significantly enhanced. Despite the high applicability of the proposed research methods and conclusions, certain limitations remain. First, the analysis is based on existing data, which may not encompass all possible influencing factors. Second, the construction of the network DEA model and the implementation of optimization strategies depend on specific teaching environments and datasets, which may require adjustments and validation in other educational contexts. Future research could expand the range of data samples to include more types and levels of mobile English education environments to verify and refine the current model and conclusions. Additionally, the exploration of other advanced data analysis methods in conjunction with network DEA could further enhance the precision and applicability of the decision model. Moreover, investigating the decision process in mobile English education environments across different cultural backgrounds could provide more comprehensive and universally applicable optimization strategies and implementation plans. This would facilitate the global promotion and application of the study's findings, achieving broader educational optimization and improvement.

6 ACKNOWLEDGEMENT

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