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MOBILE SMART APP AND ITS APPLICATION IN IMPROVING THE EFFICIENCY OF ENGLISH HOMEWORK CORRECTION

HUIYING SHAO* AND ZAN LIU†

Abstract. The heavy amount of English homework correction has resulted in Teachers' lax examination of homework, insufficient attention to homework problems, and low attention to homework correction. With the continuous growth of the number of educated people, more and more schools begin to have the problem of low efficiency of English homework correction. Therefore, in order to optimize the homework correction system, improve the efficiency of English teachers' homework correction, and give full play to teachers' positive feedback on homework, a smart app on mobile phone can be developed to scan and correct traditional paper homework. Based on image processing technology and neural network algorithm, this paper designs and establishes a mobile app that can recognize and extract English homework topics and handwriting with nearly 90% accuracy through Android system platform. Based on the homework answers entered in the database, the rapid correction of English homework can be realized. After using this software, the overall efficiency of English homework grading has significantly improved. For multiple-choice and fill in the blank questions, the total factor productivity of 14 and 15 units was greater than 1, accounting for 63.6% and 68.1% of the nursing units participating in the study, respectively. This indicates that the efficiency of English homework grading in most units is constantly improving and showing a good development trend. Among them, the homework correction efficiency for multiple-choice questions is only 6 units, and the pure technical efficiency is less than 1, indicating that the improvement of technical means has a significant impact on efficiency. In order to verify the applicability of the software, data envelopment analysis is used to analyze the application of the mobile app to improve the efficiency of English homework correction. the results show that when the smart phone software is not put into use, the efficiency of teachers' English homework correction is poor, and the technical level in the process of correction is too low. After the mobile intelligent software is put into use, the overall efficiency of English homework correction has increased significantly, which can greatly alleviate the pressure faced by English teachers in the process of correcting homework.

Key words: Mobile Smart app, English homework, Image processing technology, Neural network algorithm, Data envelopment analysis, Efficiency

1. Introduction.

Homework is an important and effective management means in the teaching process [1]. It can consolidate the teaching content by repeating the existing knowledge or skills [2]. In China, English is an important compulsory course, which is studied by all students in primary school. Although the proportion of English in school subjects has declined in recent years, English is still one of the most concerned courses for students and teachers. However, with the continuous improvement of education level and the continuous growth of the number of educated people, teachers are facing increasing pressure on teaching. the increasing number of examinations and relatively few class hours have brought great trouble to English teachers. the heavy amount of English homework correction has resulted in Teachers' lax examination of homework, insufficient attention to homework problems, and low attention to homework correction [3]. These problems not only weaken the consolidation effect of homework on teaching content, but also increase the burden on students. Even the inefficient efficiency of homework correction will curb students' motivation to complete homework and seriously affect students' interest in learning English courses [4]. Therefore, optimizing the homework correction system, improving the efficiency of English teachers' homework correction, and giving full play to teachers' positive feedback on homework are the most important problems to be solved in current English teaching. Applications can utilize natural language processing and machine learning techniques to automatically analyze students' English homework and provide precise feedback and suggestions. Compared with traditional grading methods, intelligent grading can reduce human errors, improve the accuracy and efficiency of grading. Analyze students' homework through algorithms, identify potential problems such as grammar errors, improper vocabulary usage,

*Department of Economic Management, Yantai Engineerig and Technology College, Yantai Shandong 264006, China (huiyingshaoh@outlook.com)
†Department of Industrial Technology Application, Yantai Engineering and Technology College, Yantai Shandong 264006, China

etc., and present these problems to students in an intuitive way. This approach can help students better understand their own problems and guide them to focus more on these issues, improving learning outcomes. In addition, the application can also provide real-time grading feedback, allowing students to timely understand their homework situation and make improvements based on problems. This feedback method can help students better grasp knowledge and improve learning efficiency.

There are some problems in the traditional method of correcting English homework. Firstly, lax exams are one of the important issues. Due to the limitations of manual grading, it is difficult to comprehensively and meticulously evaluate each student's homework, which can easily lead to unfair evaluation. Secondly, insufficient attention is also a problem. Manual grading is easily affected by fatigue and negligence, making it difficult to maintain a high level of attention, and can easily lead to grading errors and omissions. Finally, low efficiency is also a problem. Manual correction requires a lot of time and effort, especially in situations with a large number of students, and the efficiency of correction is low, making it difficult to meet teaching needs. Mobile intelligent applications have become an important tool in people's daily life and work. Especially in the field of education, mobile intelligent applications have brought many innovations and conveniences to the teaching and learning process. Among them, as a global language, the importance of teaching and learning English is self-evident. The grading of English homework is an important part of the teaching process, which not only helps students understand their learning situation, but also helps teachers evaluate the quality of teaching. However, traditional English homework grading methods suffer from problems such as lax exams, insufficient attention, and low efficiency, which seriously affect the effectiveness of teaching and learning. Therefore, how to use mobile intelligent applications to solve these problems and improve the efficiency and quality of English homework grading has become a current research hotspot.

Mobile intelligent applications have the characteristics of portability, real-time performance, and personalization, which bring new ideas and methods for English homework correction. Firstly, mobile intelligent applications can automatically correct grammar and vocabulary errors in English homework through technologies such as natural language processing and machine learning, reducing human errors and omissions, and improving the accuracy and efficiency of correction. Secondly, mobile intelligent applications can conduct in-depth analysis and understanding of students' homework, identify their problems, and provide personalized learning suggestions and improvement plans to help students better grasp knowledge and improve learning outcomes. Finally, mobile intelligent applications can provide real-time feedback on grading, allowing students to timely understand their homework situation and make improvements based on problems, thereby improving learning efficiency. In summary, mobile intelligent applications have great advantages and potential in improving the efficiency and quality of English homework grading. By utilizing mobile intelligent applications, the problems existing in traditional grading methods can be solved, the accuracy and efficiency of grading can be improved, and students can better grasp knowledge and improve learning outcomes. Therefore, this article further explores the application and optimization strategies of mobile intelligent applications in English homework correction, bringing more convenience and innovation to the teaching and learning process.

2. Related Work. In recent years, more and more schools have begun to pay attention to improving the efficiency of homework correction [5]. With the development of information technology and computer technology, electronic homework, online examination and online learning have become important teaching means in Colleges and universities. Although English is not an important course in all countries, foreign intelligent homework systems started early, which can provide reference experience for China. Among them, the more distinctive ones are the web assign platform developed by the Department of physics of North Carolina State University in the United States [6], the WebCT platform developed by the Department of computer science of Columbia State University, the owl system developed by the computer teaching technology center of the University of Massachusetts [7], and the online operation system developed by fern University Hagen in Germany [8]. Through these systems, teachers can mark homework online and realize the statistical analysis of students' homework scores [9]. This greatly improves the efficiency of teachers' homework correction and helps teachers understand students' learning conditions. However, compared with the homework design in other countries, China has higher requirements for the standardization of homework. At the same time, many schools still use traditional paper homework because English homework contains multiple-choice questions, composition questions, judgment questions and other types of questions. This makes it difficult to promote the network

operation system in China. We should consider developing an intelligent correction system that can scan and process paper operations. With the increasing popularity of smart phones and the growing maturity of mobile camera technology, for domestic educational institutions, developing a smart app that can be used for mobile phones to scan and correct traditional paper homework has quite important social significance and economic value. Image processing technology [10] is a subject developing with the development of human civilization. With the mass production of image data, image processing technology has gradually become a special subject. the rise of computer technology has made a qualitative change in image processing technology. Compared with image analog processing, digital image processing has gradually become the main body of image analysis technology. In the 1970s, relying on computer technology, digital image processing and analysis technology has been booming and widely used. Digital image processing technology has gradually entered many fields [11], industries and people's lives.

Artificial neural networks can learn rules and patterns for grading homework by training a large number of English homework samples. Then, use these rules and modes to automatically grade students' English homework, improving the efficiency of grading. Artificial neural networks can analyze students' English homework and detect common errors such as grammar, spelling, and tense. This can help teachers identify student problems more quickly and provide timely guidance and correction. Different types and difficulty levels of English homework require selecting different artificial neural network models for training. Therefore, it is necessary to choose a suitable model based on the actual situation to ensure the accuracy and efficiency of the correction. In summary, artificial neural networks have broad application prospects in improving the efficiency of English homework grading. It can automatically correct errors, detect errors, provide intelligent prompts, and evaluate feedback, thereby improving the efficiency and accuracy of correction. The research of artificial neural networks [12] originated from the interdisciplinary research of physics, psychology and neurophysiology by Herman von Helmholtz, Ernst Mach and others in the late 19th century. In the late 1950s, Frank Rosenblatt proposed perceptron networks and associative learning rules, This makes the neural network initially have the ability of pattern recognition, and has aroused the world's interest in the research of computer network [13]. In the following decades, thousands of papers have appeared in the field of neural network research. the continuous progress of computer technology makes it possible to use high-speed computing institutions to build neural networks to solve practical problems. Neural networks are widely used in aviation, medicine, economics, electronic engineering and other fields [14], such as aircraft flight control system, cancer cell analysis, corporate financial analysis, integrated chip layout and machine vision.

Data Envelopment Analysis (DEA) [15] is a decision-making method proposed by James et al. (1978). This analysis method is also called DEA model. DEA model is a nonparametric estimation method of linear programming [16]. DEA model integrates management, mathematics, operations research and other multidisciplinary knowledge. Convex analysis and linear programming are the main analysis tools to calculate the efficiency between the same decision-making units, and thus realize the evaluation of the evaluation object. Data Envelopment Analysis (DEA) is a non parametric efficiency evaluation method used to evaluate the relative efficiency of decision units (DMUs). DEA can be used to analyze the efficiency and effectiveness of mobile applications in improving the efficiency of English homework grading. In DEA, DMU is the object to be evaluated. In this assessment, each teacher or student who uses mobile applications for English homework grading can be considered as a DMU. Choosing appropriate input and output indicators is a key step in DEA analysis. For English homework correction, input indicators can include correction time, correction frequency, and computational resources used. Output indicators can include accuracy of grading, mastery of student knowledge points, etc. The result of Data Envelopment Analysis (DEA) is the relative efficiency value of each DMU. These results are used to evaluate the effectiveness of mobile applications in improving the overall efficiency of English homework grading. If the DEA results show that the use of mobile applications significantly improves the efficiency and quality of grading, then it can prove the effectiveness of mobile applications. To demonstrate the effectiveness of mobile applications in improving the overall efficiency of English homework grading, DEA results need to be compared and analyzed with the following factors. If the correction time is significantly reduced after using a mobile application, it can indicate that the mobile application has improved the efficiency of correction. If the number of corrections significantly decreases after using a mobile application, it can also indicate that the mobile application has improved the efficiency of corrections. In the implementation and evaluation process of

smart applications, the following limitations or challenges may be encountered: the development and maintenance of smart applications require professional technical and resource support. If there is a lack of relevant technology and resources, it may impose limitations on the implementation and evaluation of the application. Intelligent applications need to handle sensitive data, such as student assignments and personal information. If data privacy and security are not guaranteed, it may pose challenges to the implementation and evaluation of applications. Related studies have shown that the implementation of AR technology has a significant positive impact on the motivation level of learners towards teaching materials in the classroom. AR technology in the classroom is an interactive and entertaining tool that transforms a monotonous learning atmosphere into an engaging and effective learning atmosphere. AR strengthening foreign language education significantly improves students' attitudes towards English courses and increases their beliefs in English self-efficacy [17].

To sum up, based on image processing technology and neural network algorithm, this paper establishes a mobile app that can extract data from scanned paper job pictures through cloud processor. Based on the homework answers entered in the database, the rapid correction of English homework can be realized. At the same time, data envelopment analysis is used to analyze the application of the mobile app to improve the efficiency of English homework correction, which proves the rationality and applicability of this method.

3. Methods.

3.1. Image processing technology. For a picture, the discrete function f (x) involving two variables can be used to describe it. This function is the image function, which can be expressed by matrix, and its definition domain is as shown in formula (2.1):

$$R=\{(x,y)\ ,\ 1\le x\le x_m, 1\le y\le y_n\} \tag{3.1}$$

where x_M and y_M represent the maximum coordinates of the image, which is related to the size and resolution of the image.

The basic unit of digital image is called image element, which is called pixel for short. the spatial resolution of image is proportional to the pixels it contains. An image can be represented as a two-dimensional matrix (each element represents a pixel) as shown in formula (3.2), where m and V are the number of rows or columns of the image respectively:

$$F=\begin{bmatrix} f_{11} & f_{12} & \cdots & f_{1N} \\ f_{21} & f_{22} & \cdots & f_{2N} \\ \cdots & \cdots & \cdots & \cdots \\ f_{M1} & f_{M2} & \cdots & f_{MN} \end{bmatrix} \tag{3.2}$$

By integrating the brightness of image pixels, the global information can be extracted from the original image matrix, which makes the calculation process simple. the specific formula is as shown in formula (3.3):

$$ii\,(i,j)=\sum_{k\le i,l\le j} f\,(k,l) \tag{3.3}$$

Hierarchical data structure is an important part of image processing. In order to improve computing efficiency, t-pyramid structure is usually used. the structure is a tree as shown in Figure 3.1. Let 2L be the maximum resolution of the image. the definition of t-pyramid is: a node set P is as shown in formula (3.4).

$$P=\{P=(k,i,j)\ \left|k\in[0,L]\,;i,j\in\left[0,2^k-1\right]\right.\} \tag{3.4}$$

Mapping between nodes F is as shown in formula (3.5):

$$F\,(k,i,j)=\left(k-1,\frac{i}{2},\frac{j}{2}\right) \tag{3.5}$$

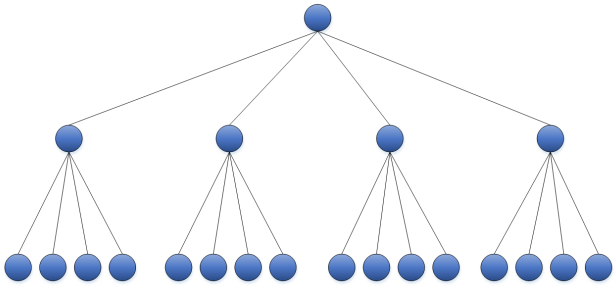

Fig. 3.1: Structure diagram of t-pyramid neural network

3.2. Artificial neural network technology.. Neural network is a collection of interconnected neurons, and the computer meridian element is the basic unit to complete data processing in the network. Through the learning of neurons, it can find the linear or nonlinear relationship between input and output from the network input data, so as to produce output prediction for future input signals. In practical applications, neurons are often designed as a processor or processing unit that can accept input signals and generate a single output signal. When the input signal enters the neuron, there will be a weight associated with it to generate an input function. Similarly, in most cases, the output is also a function of the weighted sum of the input signals. Let the neuron input signal be represented by $V1, V2$. And the corresponding input weights are $W1, W2...$, and then the actual input of the neuron is as shown in formula 3.6:

$$x = \sum_{i=1}^{n} v_i w_i - b \tag{3.6}$$

Where B is the bias value related to the neuron, and the output transfer function $f(x)$ of the neuron is generally expressed in the following two forms listed in formula (3.7) and (3.8):

$$f(x) = \begin{cases} 0, x \leq 0 \\ 1, x > 0 \end{cases} \tag{3.7}$$

$$f(x) = \frac{1}{1+e^{-x}} \tag{3.8}$$

The neurons in the neural network are operated in parallel. the set of these neurons operated in parallel is called the layer of the neural network. A layer composed of s neurons can be represented by Figure 3.2. the number of input signals in the figure is R.

3.3. Data envelopment analysis. Data envelopment analysis is a method to evaluate the relative efficiency between decision-making units. It is suitable for evaluating the efficiency of decision-making units with multiple inputs and outputs, and the evaluation results are not affected by the index measurement unit, and the model it establishes does not need to deal with the data dimensionless. At present, the commonly used analysis model CCR model has the following main conditions listed in formula (3.9):

$$\begin{cases} \max h_{j0} = \frac{\sum_{r=1}^{s} u_r y_{rj_0}}{\sum_{i=1}^{m} v_i x_{ij0}} \\ s.t. \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1, j = 1, 2, \cdots, n \\ v = (v_1, v_2, \cdots, v_m)^T \geq 0 \\ u = (u_1, u_2, \cdots, u_s)^T \geq 0 \end{cases} \tag{3.9}$$

In which:

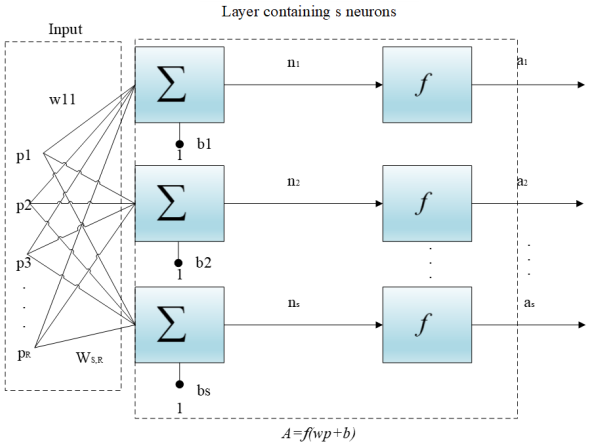

Fig. 3.2: Schematic diagram of layered neural network structure

1. x_{ij} is the input of type i of the jth decision-making unit;
2. y_{rj} is the output of type r output of the jth decision-making unit;
3. v_i is the weight of the i-th input;
4. u_r is the weight of the r-th output;

Through dual transformation and the introduction of relaxation variable s+ and residual variable s-, the above model can be changed into formula (3.10):

$$\begin{cases} \min \theta \\ s.t. \sum_{j=1}^{n} \lambda_i x_j + s^+ = \theta x_0 \\ \sum_{j=1}^{n} \lambda_j y_j - s^- = \theta y_0 \\ \lambda_j \geq 0, j = 1, 2 \cdot \cdot, n \\ \theta no \lim its \\ s^+ \geq 0, s^- \leq 0 \end{cases} \tag{3.10}$$

Where θ is the effective value of the decision-making unit, and its value has different meanings under different conditions:

1. θ= 1. And s+=0, it means that the cardinality effect and scale of the decision-making unit are effective at the same time.
2. θ= 1. If the input or output is not all positive, it indicates that the cardinality effect and scale of the decision-making unit are not effective at the same time.
3. θ< 1, it indicates that the cardinality effect and scale of the decision-making unit are not effective.

The reason for choosing data envelopment analysis (DEA) in this paper is that data envelopment analysis (DEA) does not need to consider the functional relationship between input and output, nor the assumption of estimating parameters and index weights in advance, so as to avoid the differences caused by researchers' subjective assumptions. At the same time, for non DEA effective decision-making units, it can analyze the redundancy and deficiencies of input and output, and find the direction of further improvement.

4. Establishment of software.

4.1. identification technology process. In order to improve the accurate capture of the questions and answers, in the recognition process, first of all, the homework pictures scanned by the mobile phone are meshed, and the image files are cut according to the small questions and the topic numbers are recognized. By constantly moving the search area to search the question box by box, based on the entered job related information, the normalized correlation matching method is used to calculate the matching degree returned after each match,

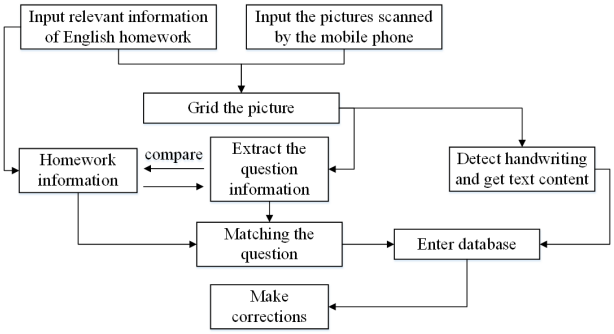

Fig. 4.1: Detection process of English homework scanning and content extraction

and finally the threshold is used to determine whether the result is matched. the matching formula of normalized similarity measurement is as shown in formula (4.1):

$$R_{\text{value}}^{\text{ij}}=\frac{\sum_{\text{i=1}}^{\text{m}}\sum_{\text{j=1}}^{\text{n}}\left[S^{\text{i,j}}\left(m,n\right)T\left(m,n\right)\right]}{\sqrt{\sum_{\text{i=1}}^{\text{m}}\sum_{\text{j=1}}^{\text{n}}\left[T\left(m,n\right)\right]^{2}}\sqrt{\sum_{\text{i=1}}^{\text{m}}\sum_{\text{j=1}}^{\text{n}}\left[S^{i,j}\left(m,n\right)\right]^{2}}} \tag{4.1}$$

After determining the topic, determine the topic range according to the spacing between adjacent question number boxes. the handwriting in the title is detected by edge detection, and the text content is obtained. the segmentation of re-use image cuts out the answer content and question part, and finally enters them into the database respectively for subsequent automatic correction. the specific detection process is shown in Figure 4.1.

4.2. Optimization of neural network algorithm. Considering the richness of English homework questions, the software algorithm adopts BP algorithm with multi-layer network structure. This method optimizes grid computing and sensitivity recursion based on Jacobian matrix (formula 4.2) and chain method.

$$F^{\text{m}}\left(n^{m}\right)=\begin{bmatrix} f^{m}\left(n_{1}^{m}\right) & 0 & \cdots & 0 \\ 0 & f^{m}\left(n_{2}^{m}\right) & \cdots & f_{2N} \\ \cdots & \cdots & \cdots & \cdots \\ 0 & 0 & \cdots & f^{m}\left(n_{n}^{m}\right) \end{bmatrix} \tag{4.2}$$

The implementation process is mainly based on three steps:

1. the input is transmitted forward through artificial neural network.
2. the sensitivity is back propagated through the grid.
3. Use the steepest descent method to update the weight and offset values.

Based on this algorithm, the matching condition of the scanned image of an English homework is calculated, the image is scanned line by line and then column by column, and the matrix is established in the memory. Finally, the grid error change curve is shown in Figure 3.2:

It can be found that the step error of 140 calculation under this algorithm can be stabilized to a small value, indicating that the calculation is relatively stable. At the same time, English assignments of different question types are selected for topic and handwriting extraction. the overall recognition rate is shown in Table 5.1:

Combined with the recognition rate results, it can be found that the recognition rate of the algorithm for the topic and handwriting is more than 90%, the operation is stable and reliable, and it can recognize the topic content and handwriting in English homework more accurately, which provides a guarantee for the subsequent rapid correction.

This new comprehensive detection method has the following advantages over the traditional answer card verification technology:

1. the algorithm is simple to realize and the development cost is low. the software developed in this paper uses the principle of exclusion method. After identifying the question number and handwriting, it will

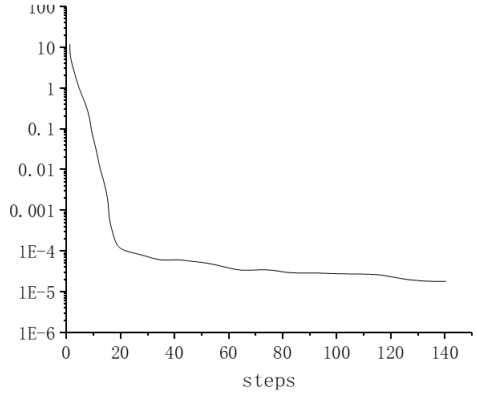

Fig. 4.2: The change of the grid error with steps

Table 4.1: The overall recognition rate of English homework

Number	choice question	Blank filling questions	On answering questions
1	92.3%	99.5%	97.0%
2	92.4%	98.1%	92.9%
3	99.9%	95.0%	91.3%
4	94.4%	95.8%	90.4%
5	94.4%	93.5%	98.4%
6	97.2%	94.3%	96.6%
7	91.6%	96.0%	92.1%
8	95.5%	94.8%	95.6%
9	95.1%	91.3%	94.4%
10	97.2%	94.4%	94.0%
11	98.9%	99.5%	96.9%
12	97.8%	92.0%	92.8%
13	98.6%	94.8%	98.5%
14	93.7%	98.5%	91.5%
15	98.6%	98.3%	92.8%
16	97.5%	90.8%	90.6%
17	93.9%	94.3%	94.6%
18	95.5%	94.4%	96.6%

automatically scan the questions and answers centered on it. the shape of the recognition object is simple, the block area is small, and the noise influence is small after image preprocessing, and the matching quality can be further improved by image compression, variable step matching and other optimization methods;

2. Through the grid division of the scanned image, it can provide rough coordinate positions for all inspections, so that the reviser can automatically locate the topic he wants to find;
3. the statistical characteristics of the image change obviously, and the error recognition rate is low. 4. Without relying on a card reader, you can scan and extract pictures in batches only with a smart phone, which greatly shortens the correction time.

4.3. Implementation of Mobile Smart app. Mobile Smart app is designed based on Android development platform. In this study, the development under Android is based on eclipse development environment. As an open source, Java based extensible development platform, eclipse can be used as Java integrated develop-

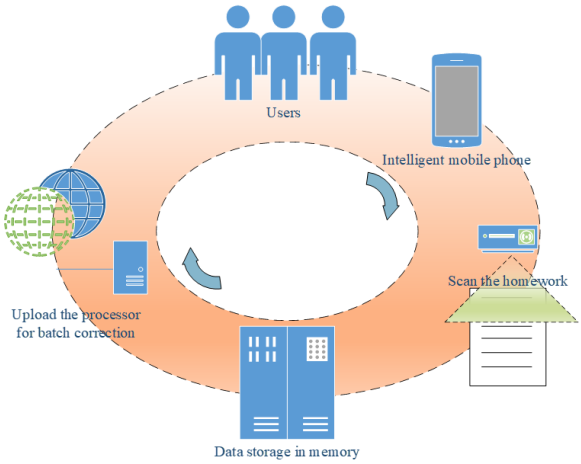

Fig. 4.3: The specific process for the Mobile Smart app

ment environment (IDE), including plug-in development environment (PDE). the main functions of the mobile smart app designed in this paper include uploading scanned pictures, connecting with the processor, inputting answers and outputting correction results. the specific process is shown in the Figure 4.3 below.

5. Analysis of English homework correction efficiency based on DEA static analysis. In order to better analyze the dynamic change law of the human resource efficiency of each nursing unit, this study, based on the DEA static analysis, combined with the Malmquist index model, further investigated the change law and heterogeneity of the English homework correction efficiency of each teaching unit by analyzing the relevant data of teachers in each school in terms of English homework correction and question type.

5.1. index introduction. Malmquist (1953) proposed Malmquist index in the early 1950s. At present, this method is mostly used together with data envelopment model. This index uses the ratio of distance function to calculate the input-output index. With the help of Malmquist index analysis, the efficiency changes of decision-making units in different cycles can be analyzed by the formula (5.1).

$$M_{j0}^{t+1}\left(X_{j0}^{t+1},Y_{j0}^{t+1},X_{j0}^{t},Y_{j0}^{t}\right)=\left[\frac{F_{j0}^{t}\left(X_{j0}^{t+1},Y_{j0}^{t+1}\right)}{F_{j0}^{t}\left(X_{j0}^{t},Y_{j0}^{t}\right)}\bullet\frac{F_{j0}^{t+1}\left(X_{j0}^{t+1},Y_{j0}^{t+1}\right)}{F_{j0}^{t+1}\left(X_{j0}^{t},Y_{j0}^{t}\right)}\right]^{\frac{1}{2}} \tag{5.1}$$

According to the definition of Malmquist productivity index, it can be divided into technology change and resource allocation efficiency change rate. the former refers to the ratio of the actual input and the maximum output of the enterprise under the given input factors, and the latter refers to the optimal combination of given output input under the given technology and price conditions. By decomposing Malmquist productivity index, it can be regarded as the similar reasons for improving comprehensive efficiency, and the efficiency changes caused by multi index changes can be comprehensively considered. the formula used in the analysis is as follows:

$$AC_{i}^{t+1}\left(y^{t+1},x^{t+1},y^{t},x^{t}\right)=\frac{F_{i}^{t+1}\left(y^{t+1},x^{t+1}\right)}{F_{i}^{t}\left(y^{t},x^{t}\right)} \tag{5.2}$$

$$M_{i}^{t+1}\left(u^{t+1},x^{t+1},u^{t},u^{t}\right)=TC_{i}^{t+1}\left(y^{t+1},x^{t+1},y^{t},x^{t}\right)\bullet AC_{i}^{t+1}\left(y^{t+1},x^{t+1},y^{t},x^{t}\right) \tag{5.3}$$

According to the definition, when the productivity index$M_{i}^{t+1}\left(u^{t+1},x^{t+1},u^{t},u^{t}\right)>1$, the comprehensive efficiency improves. If the change rate of one of the items after the decomposition of Malmquist productivity index is greater than 1, it indicates that this item is the reason for improving the comprehensive efficiency. If a certain item is less than 1, it indicates that this indicator is the reason for the decline of efficiency.

Table 5.1: The research results of comprehensive efficiency, pure technical efficiency and scale efficiency calculated

	choice question			Blank filling questions		
Research unit	CE	TE	SE	CE	TE	SE
1	1.10	0.94	0.74	1.03	0.24	0.46
2	0.50	0.88	0.27	0.20	0.35	0.23
3	1.07	0.98	0.30	0.37	0.33	0.26
4	0.93	0.61	1.11	1.19	1.08	0.42
5	1.00	0.96	0.88	1.01	0.86	0.93
6	0.35	0.46	0.60	0.80	0.96	0.50
7	1.03	0.38	0.77	0.44	0.26	1.08
8	0.69	0.40	0.63	0.80	1.06	0.97
9	0.95	0.49	0.66	0.49	0.94	0.98
10	0.71	0.91	0.34	0.25	0.34	0.92
11	0.38	0.33	0.91	0.23	0.32	0.72
12	0.40	0.26	1.03	1.13	0.77	0.38
13	0.79	0.69	0.81	0.95	0.86	0.70
14	0.76	1.11	0.65	1.19	0.97	0.41
15	1.12	0.30	1.16	0.57	0.86	1.02
16	1.13	0.46	1.20	0.60	0.50	1.12
17	0.40	0.78	0.99	1.06	1.07	0.55
18	0.83	0.95	0.31	0.90	1.12	0.32
19	0.44	1.15	0.33	0.60	0.42	0.74
20	0.43	0.52	0.47	0.95	0.21	0.82
21	0.35	0.93	0.94	0.21	0.47	0.90
22	0.89	0.95	1.05	0.73	0.45	0.78
Means	0.74	0.70	0.74	0.71	0.66	0.69

5.2. Data source. The research data mainly comes from the teaching data provided by the school after the software is put into use. The survey mainly involves the allocation of related resources such as time investment, manpower investment, and grade output for different question types in homework grading for each teaching unit. In addition, for the collected data indicators, establish a database using Excel, organize team professionals to inspect the collected data, and check and correct abnormal data.

5.3. Analysis results. After screening, 22 teaching units were selected as the research object to carry out efficiency research, and the input and output indicators of multiple-choice questions and blank filling questions were calculated and analyzed. When teachers do not use this software to correct English homework, the research results of comprehensive efficiency, pure technical efficiency and scale efficiency calculated are shown in Table 5.1. In the table, CE represents comprehensive efficiency, TE represents technical efficiency, and Se represents scale efficiency.

From the perspective of comprehensive benefit index, teachers' efficiency in correcting multiple-choice questions and blank filling questions has not reached DEA effectiveness, with average comprehensive efficiency of 0.74 and 0.71 respectively, and average scale efficiency of 0.74 and 0.69; the average pure technical efficiency is 0.70 and 0.66. the efficiency of filling in the blank is relatively poor, but the correction efficiency of the two types of questions is at a low level.

Through the comparative analysis of the resource efficiency of decision-making units from the perspective of the development of each unit, it is found that only 6 units, accounting for 27.3% of the total, have achieved effective comprehensive efficiency in the correction of multiple-choice questions, and the resource efficiency of the other 16 research units is less than 1, indicating that the input-output has not reached the optimal state. There are only 6 units with effective comprehensive efficiency of correcting blank filling questions, indicating that the input and output have not reached the optimal state.

Table 5.2: The research results of comprehensive efficiency, pure technical efficiency and scale efficiency calculated

	Choice question			Blank filling questions		
Research unit	CE	TE	SE	CE	TE	SE
1	1.17	0.85	1.37	1.11	1.48	0.87
2	1.14	0.78	1.58	0.98	1.31	0.86
3	1.61	0.93	0.95	1.56	1.24	0.99
4	0.82	1.48	1.59	1.03	1.19	1.13
5	1.26	1.64	1.66	1.22	0.98	1.22
6	1.49	1.10	0.84	1.68	1.19	1.22
7	1.50	0.72	1.02	0.70	1.07	1.55
8	1.64	1.04	1.01	1.48	0.78	1.17
9	1.47	1.46	1.49	1.18	1.29	1.47
10	1.39	0.90	0.98	1.30	0.73	0.89
11	1.63	1.52	1.46	1.12	1.31	1.20
12	0.72	0.97	1.12	0.81	1.32	1.69
13	1.22	1.24	1.16	0.76	1.29	1.11
14	1.70	1.46	1.35	1.31	1.47	0.92
15	0.76	1.42	0.89	0.73	1.40	1.09
16	1.61	1.35	1.18	1.51	0.93	1.31
17	0.87	1.32	0.76	1.53	1.23	1.25
18	1.26	0.83	1.48	1.32	1.35	1.11
19	1.14	1.16	1.04	1.11	1.31	1.08
20	1.51	1.06	1.60	0.87	0.78	1.56
21	0.79	1.62	1.34	0.89	0.91	1.58
22	0.88	1.08	1.56	1.44	1.05	1.23
Means	1.25	1.18	1.25	1.17	1.16	1.20

From the perspective of decomposition, that is, comprehensive technical efficiency = pure technical efficiency × Scale efficiency, analyze the nursing units with relatively ineffective comprehensive technical efficiency. the pure technical efficiency of only two nursing units in the correction of multiple-choice questions is greater than 1, while the scale efficiency is less than 1, indicating that the scale efficiency is the main factor restricting the efficiency, and measures need to be taken to optimize the correction methods and improve the scale efficiency. the pure technical efficiency of four nursing units was greater than 1, while the scale efficiency was less than 1. All the above shows that scale efficiency is the main factor restricting efficiency, and measures need to be taken to optimize the correction methods and improve scale efficiency. In addition, the pure technical efficiency and scale efficiency values of 14 and 15 research units of multiple-choice questions and blank filling questions are less than 1, which also shows that the technical level is too low in the process of correcting English homework, resulting in the low efficiency of each unit.

After teachers use the software to correct English homework, the research results of comprehensive efficiency, pure technical efficiency and scale efficiency are calculated based on the data fed back by the school, which is shown in Table 5.2.

It can be found that from the perspective of the comprehensive benefit index, teachers' correction efficiency in multiple-choice questions and blank filling questions has been significantly improved, with the average comprehensive efficiency of 1.25 and 1.17 respectively, and the average scale efficiency of 1.25 and 1.20; the average pure technical efficiency is 1.18 and 1.16, which are nearly 70% higher than those without software. the correction efficiency of the two types of questions is at a high level. At the same time, it can be found that the comprehensive efficiency of teachers in correcting multiple-choice questions has increased to 16 units, accounting for 72% of the total, and the comprehensive efficiency of correcting blank filling questions has also increased to 15 units, accounting for 68% of the total, indicating that the input-output has reached an excellent state. In

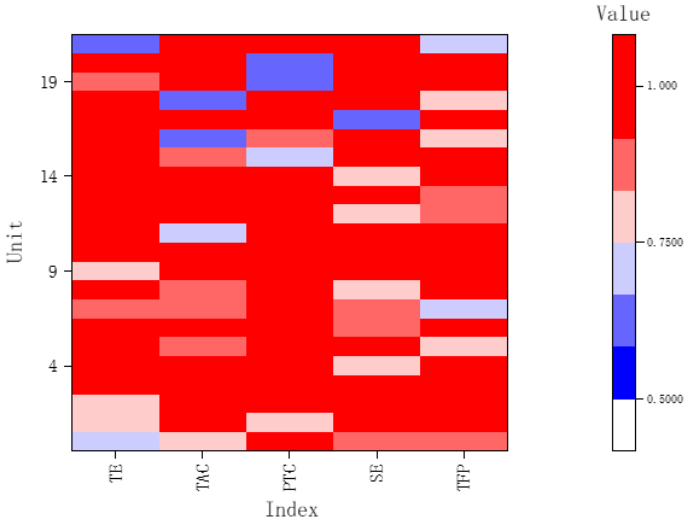

Fig. 5.1: The distribution of comprehensive efficiency, technical efficiency and scale efficiency of each unit for choice questions

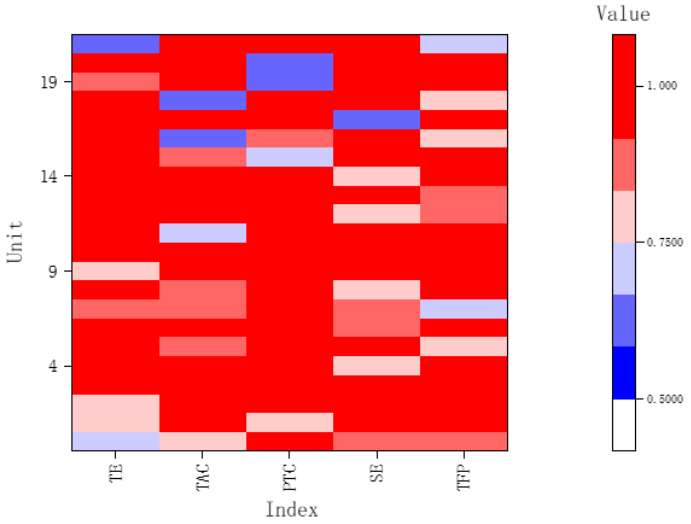

Fig. 5.2: The distribution of comprehensive efficiency, technical efficiency and scale efficiency of each unit for blank filling questions

order to better compare the changes in efficiency after correcting English homework with software, Figure 5.1 and Figure 5.2 use the form of radar chart to describe the distribution of comprehensive efficiency, technical efficiency and scale efficiency of each unit.

It can be seen from the figure that after using the software, the outline surrounded by dots and lines has expanded significantly, and all efficiency has been significantly improved. This result also shows that the software can greatly alleviate the pressure faced by English teachers in the process of correcting homework.

In order to better analyze the dynamic change law of the efficiency of each unit, the relevant data of 22 units are analyzed in combination with the Malmquist index model. After the software is tried, the heat map of

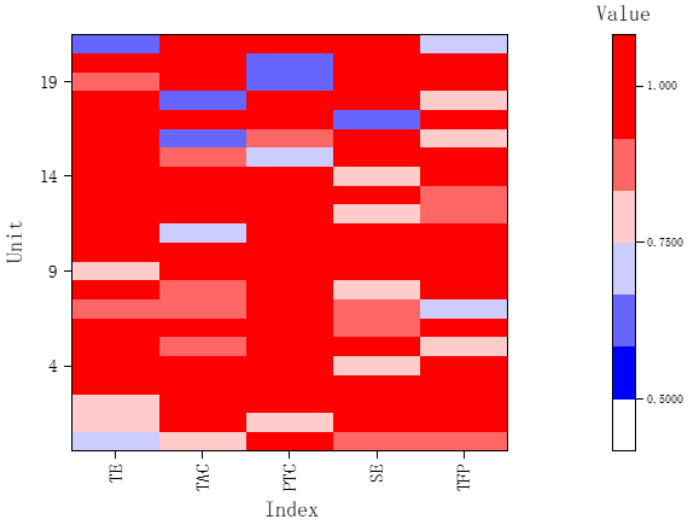

Fig. 5.3: The heat map of each efficiency index for Choice questions

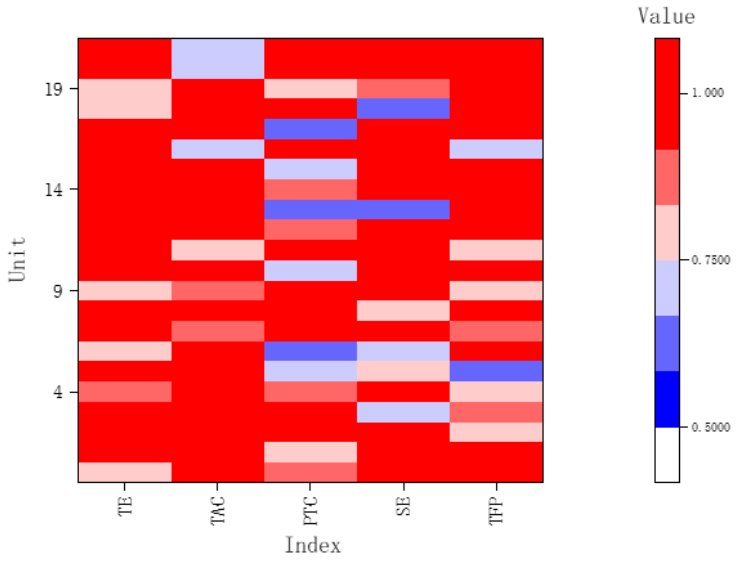

Fig. 5.4: The heat map of each efficiency index for blank filling questions

each efficiency index is listed in Figure 5.3 and Figure 5.4. In the figures, TAC refers to technological progress, PTC refers to pure technical efficiency, and TFP refers to total factor productivity:

From the efficiency index heat map of each unit, the overall efficiency of English homework correction has increased significantly after the use of the software. For multiple-choice questions and blank filling questions, the total factor productivity of 14 and 15 units is > 1, accounting for 63.6 and 68.1% of the nursing units participating in the research, indicating that the efficiency of English homework correction in most units is constantly improving, showing a good development trend. Among them, the homework correction efficiency of multiple-choice questions is only 6 units, and the pure technical efficiency is less than 1, which shows that the improvement of technical means has a great impact on efficiency.

Table 5.3: The average Malmquist efficiency index after using software to correct English homework

	TE	TAC	PTC	SE	TFP
Choice questions	1.08	1.11	1.11	1.07	1.14
Blank filling questions	1.09	1.11	0.96	1.05	1.06

The average Malmquist efficiency index after using software to correct English homework is summarized in Table 5.3.

It can be found that after the software is put into use, the values of technical efficiency, technological progress, scale efficiency and total factor productivity are all greater than 1, and the growth rate is more than 5%, except that the pure technical efficiency value of filling in the blank is less than 1. From the mean value of the three decomposition factors, the change of technological progress index has the greatest contribution to the change of total factor productivity. the choice question type and fill in the blank question type have increased by 11% respectively, the scale efficiency index has increased by 7% and 5% respectively, and the technical efficiency has increased by 8% and 9% respectively. the later investigation found that after the intelligent software was put into use, teachers' time for correcting homework was significantly reduced, providing them with more time to prepare for class preparation. Therefore, their own innovation ability was also improved, providing a continuous impetus for the overall improvement of English teachers' human resource efficiency. However, it is worth noting that for the question type of filling in the blank, due to the problems of redundant input and insufficient output of human resources in some schools, there is still a certain distance between the human resource efficiency of some teaching units and the best output.

The practical significance of mobile intelligent applications in improving the efficiency of English homework grading is very significant. The traditional method of correcting English homework usually requires teachers to spend a lot of time and effort, and sometimes it is inevitable to encounter omissions or low efficiency. Mobile intelligent applications greatly reduce the workload of teachers and improve the efficiency and accuracy of grading through functions such as automatic grading, error detection, intelligent prompts, and evaluation feedback. This can not only reduce the work pressure on teachers, but also enable them to focus more on more important tasks such as teaching design and student guidance.

In addition, mobile intelligent applications can also provide personalized learning suggestions and improvement plans, helping students better grasp knowledge points and improve learning outcomes. This personalized feedback and guidance is very beneficial for students' learning progress, as it can help them better identify their own problems and solve them in their studies. In terms of management, the implementation of mobile intelligent applications also needs to consider some challenges and issues. Firstly, the development and maintenance of applications require professional technical and resource support, therefore, schools need to invest a certain amount of funds and human resources for development and maintenance. Secondly, data privacy and security are also issues that need to be considered, and a comprehensive data management system and security measures need to be established to protect students' personal information and homework data [18, 19, 20].

6. Conclusion. In order to alleviate the pressure of English teachers in English homework correction at this stage and solve the problem of low correction efficiency. Based on image processing and artificial neural network technology, this paper designs a software that can extract the content of scanned job pictures. At the same time, a smart phone app is developed based on Android system platform and cloud server. After the mobile smart app is put into use, the efficiency analysis is carried out based on the feedback data provided by each teaching unit. the main conclusions are as follows:

1. Image processing and artificial neural network technology can better extract the content of paper English homework questions and the handwriting of answers. Based on the analysis of several cases, the designed algorithm has a recognition and extraction accuracy of 90% for English homework topics and handwriting. Based on the Android system platform, a stable and reliable intelligent app is developed. Its main functions include uploading scanned pictures, connecting with the processor, inputting answers and outputting correction results. the software can improve the speed of English teachers' English homework correction.

2. When the smart phone software is not put into use, it can be found that the efficiency of teachers' English homework correction is poor based on the data fed back by each teaching unit. At the same time, the technical level in the process of correcting English homework is too low, which leads to the low efficiency of each unit. This not only causes English teachers' lack of motivation to correct homework, but also leads to students' inability to consolidate the knowledge they have learned through homework. Therefore, we need to take technical means to optimize the correction methods and improve the scale efficiency.
3. After the smart phone software was put into use, the overall efficiency of correcting English homework showed a significant increase. From the mean value of the decomposition factors of the three Malmquist efficiency indexes, the change of technological progress index contributed the most to the change of total factor productivity. the choice question type and fill in the blank question type increased by 11% respectively, the scale efficiency index increased by 7% and 5% respectively, and the technical efficiency increased by 8% and 9% respectively. It shows that the software can greatly alleviate the pressure faced by English teachers in the process of correcting homework and improve the efficiency of English homework correction. However, the accuracy and efficiency of correcting mobile intelligent applications are influenced by data input and algorithm design. If the data input is inaccurate or the algorithm design is unreasonable, it may lead to deviation or errors in the grading results. Therefore, in the future, it is necessary to continuously optimize algorithms and data input methods to improve the accuracy and efficiency of grading.

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