A Content Based Course With the Assistance of Artificial Intelligence

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Abstract. This study aims to survey the efficacy of the inverted class under the concept of Content Based Instruction on postgraduate students' learning achievements. Two platforms are used in this mode: one employs mainstream collaborative filtering and Bayesian Probabilistic Matrix Factorization with big data management methods while the other utilizes a BP neural network and the model of Bi-directional Encoder Representations from Transformers. A pre-test/post-test design was adopted for this study. Results show that students of the lower English level in the experimental group performed better than those in the control group, but no significant difference was found for the high English level students between the two groups.

Keywords: inverted class, artificial intelligence, Postgraduate English, content-based

1 Introduction

Chinese postgraduate students generally receive more than ten years of language instruction in English, and yet while most have passed the Chinese CET level 6 exam, many still display inadequate comprehensive English ability, as well as inadequate English skills for academic purposes. Many researchers focused on Postgraduate English instruction reforms, such as the multiple interactive teaching model, cultivation of higher order thinking ability, team-based teaching in postgraduate Academic English, learning communities, integrating English learning with specialty studies, etc.. For example, an academic forum-based teaching method derived from project-based instruction was developed for postgraduate students' academic English teaching. This study indicated improvements in postgraduate students' research, innovation, and academic communication abilities [1]. Some researchers attempted to find alternative teaching methods and strategies to encourage students to be more actively involved in the learning process and the inverted classroom is one of these options, however the current circumstances of postgraduate English teaching in China reflects a conflict between English's high importance and students' dissatisfaction with learning outcomes. Hence, this situation appears pessimistic despite enormous efforts made by domestic English teachers. Therefore, effective solutions to improve the efficiency of postgraduate English teaching, especially integrating students' academic needs into English language instruction are urgently needed. Artificial intelligence (AI) has been widely applied in education in recent years. AI applications increased by 43% from 2018 to 2022 [2]. AI has been applied to computer-adaptive testing [3], collect and analyze

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educational data [4]. AI is also implemented in English study in China, which can provide innovative ideas for English teaching models.

2 Content-Based Inverted Class with the Assistance of AI

Content-based instruction (CBI) originated from Canada's Immersion Program for foreign English learners. Under CBI, language was considered as the medium to acquire new knowledge and was learned most effectively in purposeful, meaningful and social contexts [5]. CBI is widely used in language teaching settings and has been proven effective in improving students' linguistic skills, especially in communication. However, this approach is claimed to neglect certain skills of language such as grammar and vocabulary since it focuses more on knowledge than on the language itself. Therefore, it is a challenging task to adopt a more coherent teaching strategy to integrate language acquisition with content instruction.

One instructional strategy to enhance CBI is to implement the inverted classroom model. The inverted classroom concept is fundamentally student-centered and more efficiently reallocates in-class learning time by leaving time for students to preview the new content before attending class. The inverted classroom model has been proven effective in different academic disciplines with various learning styles. An empirical exploration of the inverted classroom teaching model in postgraduate education was conducted and demonstrated that inverted classroom can improve autonomous learning, innovation and comprehensive English language application abilities. A SPOC based inverted Classroom teaching was carried out in postgraduate oral English and the quality of postgraduate oral English courses improved.

2.1AI-based learning platforms

This study used an AI-based Automated Essay Scoring (ASE) system, the iWrite English writing teaching and evaluation system, to facilitate the course. iWrite cloud services realize AES through algorithms, corpora and multi-language processing technology. In terms of algorithms, cloud services use three algorithms based on rules, statistics, and templates. In terms of corpus, it combines native language corpora with English learners' corpora. Additionally, through cooperation with universities and the self-built corpus of iCorrect, iWrite continuously annotates data and has established a corpus for Chinese learners of English, which can identify grammatical errors frequently made by Chinese learners of English. In terms of language processing technology, cloud services adopt corpus automatic annotation, syntax analysis, Dependency parsing and composition template recognition and analysis technologies. Based on the above technologies and methods, the cloud service can automatically correct the composition and provide feedback from language, discourse structure and writing standard, thus reducing teachers' evaluation burden.

An Artificial neural network is a kind of information processing technology similar to the human nervous system. A BP neural network is a multi-layer learning method based on the classical BP algorithm, adopting minimum mean square error (MSE) correction. The operation process of BP neural network combines feedforward neural network (forward propagation) and feedback neural network (back propagation). As exhibited in Figure 1, a BP neural network is composed of three parts: the front end, X_1-X_n, which corresponds to the input layer, the middle, Y_1-Y_n, which corresponds to the hidden layer, and the end, Z_1-Z_n, which corresponds to the output

layer. Feedforward neural network is used to calculate the training error between the actual output value and the expected output value. If the training error between them is not consistent with the acceptable error, it will be back propagated and will then readjust the weight according to the training error. The above process is repeated until the processing results conform to the neural network model and zero error is achieved. Then a series of weights *w* after adaptive processing can be obtained [6].

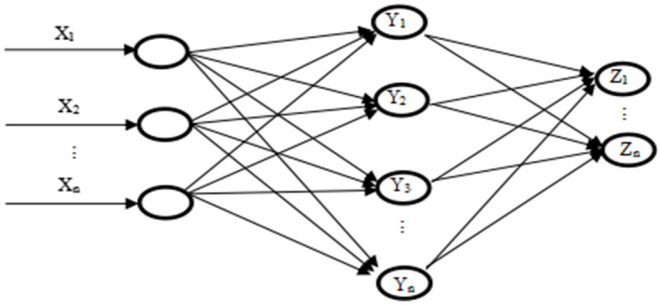

Fig. 1. Schematic diagram of BP neural network model.

$$X_i^K = f\left(U_i^K\right) = f\sum_j W_{ij} X_j^{K-1} \tag{1}$$

As shown in mathematical formula 1, suppose an *M*-layer neural network with *X* samples in the input layer. The sum of the input of the *i*th neuron in layer *K* is expressed as U_i^k, and the output as X_i. The weight of the connection from the *j*th neuron in layer *K-1* to the *i*th neuron in layer *K* is W_{ij}. The activation function of neurons is *f*.

Current scoring engines cannot solve the problem of coherence evaluation accuracy. Recently, natural language processing (NLP) models acquired positive results in discourse semantic analysis. A novel method is proposed to extract the textual semantic and structural attributes on the basis of bidirectional encoder representations from transformers (BERT) which recognizes not only semantic attributes, such as the relevancy to the theme, but also structural attributes such as structural agreement and part of speech coherence based on neural networks. Transformer's model is based upon the "attention mechanism", whose fundamental principle is to calculate the connection between every two words in a sentence, and the interconnections reflect the relevance and importance of different words in the sentence to a certain extent. The new representation of each word can be obtained by adjusting the weight of each word by using these interrelations. This new representation includes both the word itself and its relationship with other words, hence the model can obtain contextual semantic information from the input word. The BERT model consists of two stages: The first stage being the pre-training process of the model based on a large volume of general corpus of English, which the algorithm can use to learn general semantic information. The second stage is the fine-tuning process of the model based on a specialized corpus, which obtains new semantic features according to the specified professional domain, and thus performs well at specific tasks [7].

After years of exploration, iWrite has achieved great improvements in this aspect and can evaluate the relevance and coherence of input compositions. In terms of relevance, iWrite's

engine compares the semantic network constructed with key words and instruction input by teachers with that extracted from students' compositions, and obtains the relevance-score through complex operation. The combination of keywords and composition instructions can ensure accurate judgment on the compositions' relevance to the topic.

iWrite adopts the self-developed "Bert-based coherence model" to quantify the coherence of writings by modeling the semantic relevance between sentences. The coherence score provided by iWrite effectively identifies context-incoherent essays. With the help of big data and cloud computing, the iWrite system can conduct timely reviews and feed back the online texts submitted by students according to the four dimensions of language, content, structure and mechanics. Students obtain their own writing content comments, error correction and modification as well as scores, which at the same time can be received by the teacher.

3 Methodology

3.1 Participants

The study used a pre-test/post-test design to survey the efficacy of the integration of CBI with the inverted classroom model on learning achievement between experimental and control groups at a postgraduate level. This study was carried out in two classes with 65 first year education majors aged between 22 and 30 years who enrolled in a 2-credit Comprehensive English course as a requirement for their MA degree. The experimental group was composed of 33 students and the control group was composed of 32, none of whom had international study experience. Both groups used the same textbook with different methods. The experimental group undertook a lesson using the inverted class teaching mode with the concept of CBI, while the control group followed the same lesson taught with the conventional method. Both groups accepted a pre-test and a post-test before and after the treatment.

3.2 Procedure

Postgraduate English is a degree course for non-English majors within China. The purpose of this course is to train students to have more proficient reading, writing, and translating abilities with the goal of attaining intermediate to upper-intermediate listening and speaking abilities, and to apply these English skills towards their majors' academic research. To gain a more reliable result, this study lasted for two semesters with 16 weeks for each semester. Before the experiment, both classes undertook a pre-course evaluation to assess students' individual English level. Both classes attended the course for the next two semesters with different methods. At the end of the experiment, both classes took a post-course test. The pre-course evaluation aimed to guarantee the equal standing in English language level of the two classes and the post-test measured students' progress in English competency.

Prior to the first semester, students of both groups received the course materials, including the textbook, course syllabus, lesson planning, Power Point slides, additional materials and course evaluation standards, etc.. Teachers made clear the course requirements and objectives. In the control group, students' main task was to be present in the classroom-based lectures and fulfill any homework delivered by the teacher. Normally, the teacher spent 30 minutes of the total class duration (40 minutes) on lecture and 10 minutes on discussion or problem solving.

For the experimental class, students were divided into 8 groups. Each group shall fulfill the presentation in class to explicate the text assigned to them. The group members can collaborate to finish their task. In addition, the iWrite rating and 51Learning English Reading Platform systems were introduced to students to assist their writing evaluation and reading training. With the help of big data and cloud computing, the iWrite system can complete timely reviews and provide feedback concerning the online texts submitted by students from four dimensions of language, content, structure, and mechanics. Students obtain personalized writing content comments, error corrections and modifications, as well as scores, which can be received simultaneously by the teacher. The 51Learning English Reading Platform provides online testing and evaluation data and reports based on multiple dimensions, such as number of questions completed, scores, one-time accuracy, etc.. The teacher can monitor students' learning process through the platform's monitoring function as well as the generated statistics of the system such as scores, total study time, and accuracy.

Prior to the class, students previewed the textbooks related to the subject to learn how to write academic articles. Over and above textbook preview, students also had to read English literature from authoritative journals in education intensively every week to consolidate their understanding of writing academic articles as well as acquire knowledge of education. They were encouraged to take reading notes in the form of annotations on electronic documents such as certain terminologies, their understanding of the main idea of each part of the paper and the analyzing key words and sentence patterns, etc.. Every group was required to prepare a presentation with the help of Power Point slides to explain the paper they prepared.

In class, the teacher and students reviewed the content, conducted in-depth discussions to student-generated questions related to the textbook. Then students in each group made a 15-minute presentation related to one academic article in education. Besides the concepts and terms of the article, they were required to analyze different sections of related academic articles and texts, i.e., article abstract, literature review, etc.. For example, if a lesson is about how to write the abstract of an academic paper, then the group should analyze the abstract of the article such as what information elements are included in the article, what verb tenses and voices are employed in each information element in the abstract.

After finishing each chapter, students submitted their introspection on the part, including their self-assessments of improvements, confusions, as well as their advice for the class called After-Class Reflection and Assessment. The teacher communicated with students through social software such as WeChat to give instant feedback to students' questions. iWrite platform also plays the supporting role through its detailed text analysis for the teacher to provide more comprehensive feedback to students' writing.

3.3 Data collection instruments and procedure

Instruments used to elicit data in this study are two tests, pre- and post-course evaluations and focus-group interviews. Pre-course evaluations directly used the English scores of postgraduate entrance examinations, whose credibility and validity can be verified. The post-course evaluation consists of 10 vocabulary multiple-choice questions, each with four options, 2 reading comprehension essays (300-350 words for each essay) with 10 multiple-choice questions, each with four options, 1 English-Chinese translation passage, 1 Chinese-English translation passage and 1 composition essay (about 200 words). The post-test was employed

after one year's treatment to trace possible changes in the students' English competence. A one-way analysis of co-variance (ANCOVA) was administered to measure the learning improvement, using group as a between-subject variable, pre-test evaluation scores as a co-variance, and post-test scores as a dependent variable. An independent sample *t*-test was used to evaluate the effects of the teaching methods on students from different English levels. All analyses were conducted with SPSS 21. The statistical significance level was set at $p < .05$.

4 Results and Discussion

4.1 The Comparison of the Learning Results on Different Teaching Methods

Table 1 exhibits that before the instruction, an independent sample *t*-test was conducted on pre-test scores of the control group and the experimental group. Results showed no statistical difference between the two groups (*t* value = 1.206, *p* = .232). This indicated that both the groups were similar in English competencies before the experiment was carried out.

Table 1. Independent Sample t-test for Pre-test

Group	N	Mean	*SD*	*MD*	*t*-value	*P*
Control	33	61.00	7.591	1.321	1.206	.232
Experimental	32	58.84	6.783	1.199		

* $p < .05$. *SD* = Standard deviation, *MD* = mean difference.

Our hypothesis concerned the degree to which the new teaching mode might lead to variance in students' English performance. The hypothesis of this research is that the inverted instruction and learning methods would outperform the control class which would be represented on the post-test scores. To verify the hypothesis, a two-factor ANCOVA was adopted with SPSS. The independent variable is the class and the covariance was pre-test scores in order to control any original differences in the students' language capacity. Prior to administer ANCOVA, Levene's Test of Equality of Error Variance was performed to check whether or not the data were fit for ANCOVA. Since the homogeneity test has not achieved statistical significance (F =3.338; p = .073 > .05), hence ANCOVA can be used in the study. In Table 2, the tests of between-subjects effects ($P = 0.017 < .05$, $\eta 2 = .089$) show statistical significance of the post-test scores between the two groups with the experimental group performing better than the control group.

Table 2. Tests of Between-subjects Effects

Source	SS	df	MS	F	P	Partial eta squared	Observed power
Corrected model	92.155a	2	46.077	3.131	.051	.093	.581
Intercept	5894.749	1	5894.749	400.603	.000	.868	1.000
Group	87.795	1	87.795	5.966	.017	.089	.672
pre-test	11.357	1	11.357	.772	.383	.012	.139
error	897.595	61	14.715				
Total	462710.00	64					
Corrected total	989.750	63					

a. R Squared =.093 (Adjusted R Squared = .063)
b. *P < .05.

4.2 The Comparison of the Learning Results on Different English levels

Table 3 shows the students' pre- and post-test results based on different English levels for both groups. As we can find, the students' scores are not significantly different between the groups for both levels for pre-test. The post-tests still produced no significant difference for high level students (t = -.704, P = .487 >.05) between the control group and the experimental group. However, a significant difference (t = -2.565, P = .015 <.05) is found in the posttest for low levels with the control group and the experimental group. The quantitative results showed that students in the experimental group performed better than the control group after one year' s instruction. As to different English levels, students with low English level in the experimental group made obvious improvement when compared with those in the control group; while for high level students, there was no such big performing difference for both groups. This proves the effectiveness of the new mode, especially to the students with lower English level.

Table 3. Independent sample t-test for pre-test

	English Level	Group	Mean	*SD*	*MD*	*t*-value	*P*
Pre-test	High	Control	66.61	4.642	1.094	.829	.414
		Experimental	65.15	5.080	1.409		
	Low	Control	54.27	4.061	1.049	-.195	.847
		Experimental	54.53	3.687	.846		
Post-test	High	Control	84.39	4.368	1.029	-.704	.487
		Experimental	85.38	3.070	.851		
	Low	Control	83.20	4.229	1.092	-2.565	.015
		Experimental	86.61	3.415	.805		

* p < .05. *SD* = Standard deviation, *MD* = mean difference.

4.3 Reasons Accounting for the Results

Encouraging postgraduate students' language output. In spite of the decisive role of language input, language output can improve language learners' fluency and accuracy. As a crucial component of English learning, output allows English learners to be aware of their shortcomings, encourages them to engage in linguistic analysis as well to test linguistic hypotheses and receive feedback. However, it is acknowledged that Chinese English learners lack English output compared with input. Under traditional instruction, classroom is mainly occupied by lecture, so that students do not have enough time to practice and engage with the materials as well as get feedback from their teachers. By shifting part of the learning content outside of the classroom, the inverted class model allowed students to communicate or discuss some topic with each other and provided time for teachers to give instant feedback so as to encourage students to speak in class [8]. The inverted class mode motivated students to speak in class by presenting their views and asking questions and CBI provided more meaningful topics for students and facilitating vocabulary to express their thought in a certain discipline.

Encouraging active engagement in class and autonomous study at home. Engagement plays a key role in language studies, which means that students need to be actively involved in classroom activities, collaborate with peers, and seek guidance from teachers. The inverted classroom model encouraged students to participate more actively in class discussions. The inverted class model is to change the teacher-domination way of teaching process into a students-centered learning process. To avoid embarrassment, students in the experimental class

had to devote more time and efforts to text learning, which not only improved their English learning, but also motivated them to post high-quality questions in class to inspire lively discussion and deeper thinking of the whole class. This study affirms the finding that inverted learning mode increased student motivation thus improving educational outcomes [9]. The result agrees with a recent study that evaluated an inverted teaching mode based on an artificial intelligence Language Learning Platform and found a positive effect of the inverted teaching model, especially in terms of learning interest, study autonomy and class involvement [10].

5 Conclusions

This study extends the inventory of studies on applications AI technology in education. The statistical results of this study demonstrate that students in the experimental group made greater improvements than those in the control group. This also proves the effectiveness of the integration of the inverted classroom with CBI concept compared with traditional methods. The interview results not only confirm the quantitative analysis of the study, but also indicate that the new teaching mode encourages their language output and active engagement in classes and helps them develop autonomous study habits. The new mode is especially effective for students with lower English level might lie in the encouragement of output and engagement in class activities of the new teaching mode.

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