Effects of Sino-foreign co-operative teaching modes on students' learning in electronic engineering and finance engineering majors

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ABSTRACT: The different effects of three co-operative teaching modes implemented under the Sino-foreign co-operative education programme conducted by Zhejiang University City College (ZUCC) and University of Waikato (UW), New Zealand, are assessed. Data were collected, analysed and compared. Ordered Logit models of the teaching evaluation process were developed. Results using these models reveal that different co-operative teaching modes have different effects on foreign language ability, academic achievement and student satisfaction. In the deeply co-operative teaching mode, in which the foreign teachers are in charge of theoretical courses and domestic teachers facilitate the practical application of courses, the teaching effect is most satisfactory. Further analysis indicates that students with low GPA (Grade Point Average) can benefit more significantly. These results provide a scientific basis for further Sino-foreign co-operative teaching reforms.

INTRODUCTION

Sino-foreign co-operative teaching has become increasingly popular in college undergraduate education in China. Concerns about its effectiveness have stimulated a growing body of research. Some researchers insist that co-operative teaching helps to promote students' abilities [1][2], while other researchers indicate that pure foreign language classroom teaching may be too difficult for some students to understand and acquire knowledge [3]. Then, what is the actual effect of Sino-foreign co-operative teaching?

From 2012 to 2014, the Zhejiang University City College (ZUCC) in the People's Republic of China and the University of Waikato (UW) in New Zealand implemented reforms based on the Sino-foreign co-operative education programme. Such reforms compelled both the foreign and domestic teachers to co-operate in teaching *Money and Banking*, which is a obligatory course for students majoring in electronic engineering and finance engineering, and is taken in the sixth semester. The course requires two hours of theoretical teaching and two hours of practical application per week. To improve the teaching of it, the three modes of co-operative education; namely, Mode_d, Mode_f, and Mode_c, were applied and subsequently compared. The symbols d, f and c refer to the courses instructed by domestic, foreign, and both domestic and foreign teachers, respectively.

Almost all of the educational resources in the three co-operative modes are similar, using the same textbook, courseware, and the same on-line question bank. The only difference lies in the implementation. The teachers who implement the modes are different. In particular, a senior Chinese teacher was employed in Mode_d to provide bilingual education. In Mode_f, a teacher from UW was tasked to teach the same course, and in Mode_c, an international teacher was in charge of instructing theoretical courses for two hours, and a domestic teacher was responsible for the practical courses for two hours per week. These teachers maintained close ties to ensure that the theory and practical application courses were taught in a complementary manner.

The data on the effects of the teaching modes were collected and compared to answer the following questions:

a.   Which mode is the most beneficial for the acquisition of a foreign language?

b.   Which mode is the most beneficial for academic achievement?

c.   Which mode is the most efficient in promoting the overall teaching and development of students?

Moreover, this study assessed the level of significance of the effect to determine, if the teaching modes can be applied to other courses taught under the Sino-foreign co-operative education programme.

METHODOLOGY AND DATA

Questionnaire surveys on the co-operative teaching effect were administered to students in the three classes, with different co-operative teaching modes. The questionnaires were sent out and collected at the end of the course assessment to ensure the independence of the investigation and the objectivity of the data. In the questionnaires, the students were required to answer questions that relate to their personal characteristics, their evaluation of specific aspects of the course and, most importantly, the effects of the teaching modes on the students. The variables and their abbreviations are summarised in Table 1. The sample sizes of the three classes were 44, 45 and 30.

Independent sample *t*-tests on the Grade Point Average (GPA) were carried out prior to the sixth semester, for the two pairs: 1) Mode_d and Mode_f; 2) Mode_d and Mode_c. The results of the *t*-tests revealed significant levels of 0.651 and 0.731 respectively, which are higher than the critical level of confidence of 0.05. Thus, no significant difference exists among the three classes.

The students involved in the implementation of comparative teaching reform were enrolled in the same education programme. Moreover, their average GPAs were similar and they utilised similar study resources. Therefore, the different effects of teaching should be attributed not to the differences among the students, but to the differences in teaching modes.

Table 1: Variables and their abbreviations.

Variable type	Abbreviation	Corresponding variables
Explained variables	S	Overall satisfaction (5 - very good, 4 - good, 3 - average, 2 - bad, 1 - very bad)
	Eng	Evaluation of the effect on the ability of students to learn English (5 - attained significant progress, 4 - attained progress, 3 - average, 2 - attained slight progress, 1 - no progress)
	Ade	Evaluation of the effect on academic achievement (possible answers are stipulated above)
Explaining variables	$Mode_f$	Dummy variable representing education Mode_f (for Mode_f, $Mode_f = 1$, otherwise, $Mode_f = 0$)
	$Mode_c$	Dummy variable representing education Mode_c (for Mode_c, $Mode_c = 1$, otherwise, $Mode_c = 0$)
Control variables	Sex	Male, $sex = 1$; female, $sex = 0$
	GPA	GPA at the end of the fifth semester
	Res	Evaluation of the teaching resources, including the textbook, courseware and the on-line question bank (5 - very good, 4 - good, 3 - average, 2 - bad, 1 - very bad)
	Tch	Evaluation of the ability of teachers to conduct classroom teaching (possible answers are similar to those presented above)

The explained variables, including *S, Eng,* and *Ade*, indicate the effects of teaching. These variables are ordinal categorical responses with five ranks. Hence, the ordered Logit model is applicable [1][4].

Let Y represent *S, Eng,* and *Ade*. The regression models can be described as:

$$Y_{ij} = \beta_{j0} + \beta_{j1}Sex_i + \beta_{j2}GPA_i + \beta_{j3}Res_i + \beta_{j4}Tch_i + \beta_{j5}Mode_{fi} + \beta_{j6}Mode_{ci} + \delta_{ji} \qquad (1)$$

The above equation represents three different ordered Logit regressions, reflecting the effect of teaching on *S*, *Eng*, and *Ade*. Subscripts *j* and *i* refer to the different explained variables and individual students, respectively. β_j refers to the coefficients to be estimated. The coefficients of *Mode_f* and *Mode_c* are the key values that must be estimated to reveal the role of co-operative education. No variable was defined to represent the education Mode_d to avoid perfect collinearity. The coefficients of *Mode_f* reflect the different effects between Mode_f and Mode_d, and the coefficients of *Mode_c* indicate the different effects of education Mode_c when compared with education Mode_d.

For the ordered Logit models, the estimation process can be described as follows. Let:

$$X^T = (x_1, x_2, \cdots x_n)$$

representing independent variable matrix. Let:

$$P(y = j \mid x)$$

represent the probability of being rank of *j* $(j = 1, 2, \cdots 5)$.

Then, the probability of being the rank which is greater than or equal to *j* $(j = 1, 2, \cdots 5)$, i.e., $P(y \geq j \mid x)$ be equal to:

$$P(\ y\ \geq\ j\ |\ x) \ =\ P(\ y\ =\ j\ |\ x) + \mathsf{L}\ +\ P(\ y\ =\ 5\ |\ x) \tag{2}$$

The probability of $P(y \geq j | x)$ is called the cumulative probability of being of rank larger than j. Take the Logit transition:

$$LogitP_j \ =\ Logit[\ P(\ y\ \geq\ j\ |\ x)\ ] \ =\ Ln\ \frac{P(\ y \geq j|x)}{1 - P(\ y \geq j|x)}\ (j = 1, 2, 3, 4) \tag{3}$$

Ordered Logit regression can be defined as:

$$LogitP_j \ =\ Logit[\ P(\ y\ \geq\ j\ |\ x)\ ] \ =\ -\alpha_j\ +\ \sum_{j=1}^{n} \beta_{ij} x_i\ (j = 1, 2, 3, 4; i = 1, 2, \cdots n) \tag{4}$$

The above equation can be further transitioned to:

$$P(\ y\ \geq\ j\ |\ x) \ =\ \frac{1}{1 + \exp(-\alpha_j + \sum_{j=1}^{n} \beta_{ij} x_j)} \tag{5}$$

In fact, this model divides the 5 ranks into two categories: $\{1, \cdots, j\}$, and $\{j + 1, \cdots, 5\}$. The Logit represents the logarithm of the ratio of the cumulative probability of belonging to rank 5 - j to the cumulative probability of belonging to rank of 1 - j. For 5 ordinal categorical response variables, 4 cumulative Logit models can be obtained. For X_i, the coefficients in the 4 models are identical, representing the logarithm of the odds ratio (OR) of the probability for Y to improve one grade when X_i is increased by one unit. Specifically, the coefficient of X_i represents that, when controlling other independent variables, and when X_i is assigned the value of a and b, the OR can be calculated as:

$$OR = \exp[\beta_j(b - a)] \tag{6}$$

RESULTS AND DISCUSSIONS

With the use of STATA software, the estimation results for the three models were obtained by the ordered Logit regression method. Results are shown in Table 2.

Table 2: Ordered Logit regression results.

Variables	Model 1	Model 2	Model 3
	S	Eng	Ade
Mode$_f$	0.04	0.65***	-0.26*
	(0.52)	(0.00)	(0.08)
Mode$_c$	0.79***	0.59***	0.27
	(0.00)	(0.00)	(0.54)
sex	0.06	0.21	-0.08
	(0.89)	(0.72)	(0.77)
GPA	0.36**	0.34**	0.11**
	(0.03)	(0.02)	(0.04)
Res	0.18***	0.04	0.43**
	(0.01)	(0.81)	(0.02)
TA	0.82***	0.71***	0.52***
	(0.01)	(0.01)	(0.01)
/cut1	-1.36	-2.81	-0.53
/cut2	2.48	6.25	2.36
/cut3	-6.54	-3.14	3.19
/cut4	3.83	1.41	1.47
Pseudo R^2	0.55	0.51	0.50

Notes: 1) ***, **, and * denote the test statistical significance at the level of 1%, 5% and 10%, respectively. 2) The figures are the estimated coefficients for the corresponding variables and the figures in parentheses are the p values.

Further estimation can explain the above. $Mode_f$ has positive and significant effect on *Eng* in Model 2, whereas it has a negative and significant effect on *Ade* in Model 3. Considering that the teacher from UW taught in his mother tongue in Mode_f, then, the degree of English infiltration in the classroom for the foreign teacher is deeper compared with that of the Chinese teacher. The foreign teacher can impart significant cultural background knowledge to students and promote the foreign language abilities of the students [5]. Hence, the positive coefficient of *Eng*. Meanwhile, the students have paid considerable attention to understanding the contents of their textbook and what their teachers say in foreign languages; thus, they do not have enough energy to grasp in-depth professional knowledge [3][6]. The negative coefficient on *Ade* is also unsurprising. The higher degree of English infiltration in professional teaching can promote the ability of students to learn and understand English, but it can also inhibit academic achievement. Hence, the overall effect is uncertain.

The effect of $Mode_c$ was subsequently evaluated. The results show that this effect is much more satisfactory. $Mode_c$ has a positive significant effect, both on *S* and *Eng*, although its effect on *Ade* is insignificant. This finding demonstrates that the division of teaching between the foreign and domestic teachers can produce both advantages. In the 2-h theoretical teaching, students can gain substantial lessons in English comprehension. In the 2-h practical application, domestic teachers can use their mother language when necessary and provide examples that are best known to students, to reduce difficulties in bilingual education and to promote the academic achievement of students. The latter advantage is evidently observed both in Mode_d and Mode_c; thus, the effect of $Mode_c$ on *Ade* is insignificant.

The study sample was subsequently divided into two groups; namely, students_A and students_B, to test whether the education modes have different effects on different students. The respondents classified as students_A are those whose GPA was higher than or equal to the average, while the students whose GPA was lower than the average were grouped as students_B. The major regression results for the grouping samples are shown in Table 3. However, for simplicity only the coefficients of the explaining variables are reported in the table.

Table 3: Ordered Logit regression results for students_A and students_B.

		Model 1	Model 2	Model 3
		S	*Eng*	*Ade*
Students_A	$Mode_f$	0.06 (0.36)	0.21** (0.02)	0.19 (0.15)
	$Mode_c$	0.03* (0.10)	0.11** (0.04)	0.21 (0.24)
Students_B	$Mode_f$	-0.13 (0.16)	0.83** (0.01)	-0.34*** (0.00)
	$Mode_c$	0.92* (0.06)	0.69** (0.01)	0.28 (0.12)

The regression results show that the effect of teaching varies for different students. $Mode_f$ has a positive and significant effect on *Eng* for students_A, but its coefficient is only 0.21. The value is significantly less than 0.83, which is the coefficient for students_B. The results further demonstrate that $Mode_f$ has negative and significant effect on *Ade* for students_B, but its effect on *Ade* for students_A is insignificant.

The results regarding the effect of $Mode_c$ are similar. When the teaching mode is changed, students_B are more likely to be affected. In particular, $Mode_c$ has a significant and larger effect both on *S* and *Eng* for students_B than those for students_A.

Based on the above analyses, the students with higher GPAs may have stronger self-learning ability. Thus, they are less affected by the teaching modes. However, the students with lower GPAs may lack the ability to study independently. As a result, they rely on teachers to implement the studying [7]. Moreover, these students are more easily affected by the teaching modes.

CONCLUSIONS

In this study, the three modes of Sino-foreign co-operative education were applied and evaluated, and the teaching effects of these modes were investigated and compared. The ordered Logit models were developed. The results using these models revealed that the advantage of foreign teachers lies in their capability of improving the general English ability of the students majoring in electronic engineering and finance engineering. However, they are short on professional teaching. By contrast, domestic teachers possess the ability to improve the depth of professional teaching, but they always fall short in terms of improving the ability of students to learn English.

In the new co-operative teaching mode, the foreign and domestic teachers co-operate based on a definite division of labour on the same course and by considering the best points of each group of teachers. Accordingly, the teaching effect is significantly improved. The improvement on the effect of teaching when the teaching mode is changed is more readily observed in students with lower GPAs.

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