

Research on Improvement of College Students' Practical Ability in the Flipped Classroom

Lin Li and Yi Wang

Abstract—The implementation of flipped classroom contributes to the improvement of college students' practical ability. The paper explores impact factors of improvement of college students' practical ability. Four hundred and sixty-one students at a university in Southwest China were investigated. The analysis results of ordinal multi-classification logistic regression model show that factors like video lecture sources, learning task completion, lecturer in class, and classroom interactive participation, have significant influences on improvement of college students' communication and expression ability, and analysis and problem-solving ability. In order to improve college students' practical ability, it proposes that universities and instructors should take actions to provide system guarantee, motivate college students' curiosity, modify teaching design and construct mutual relationship between teachers and students, to conduct flipped classroom and improve educational effect and quality in the universities.

Index Terms—Flipped classroom, college students, practical ability improvement.

I. INTRODUCTION

In recent years, the researches on college students' practical ability have become hot topics in China. Taking CNKI (China National Knowledge Infrastructure) as the retrieval source, this study identifies about 500 relative published papers in the past five years. Previous researches have tended to explore college students' practical ability from the perspectives of subject competition, curriculum reform, major construction, training model, training ways and transformation of college. Few studies have examined college students' practical ability by flipped classroom. Chinese government has been encouraging colleges and universities to use flipped classroom to improve students' independent learning ability. To fill the research gap, this study aims to answer the following questions:

- 1) What is the definition of college students' practical ability?
- 2) What are the major factors affecting improvement of practical ability?

To analyze preceding questions, pertinent literature has been reviewed. Then, we explore the factors of college students' practical ability based on flipped classroom. Following, research design and results are presented. Finally, suggestions are proposed.

II. LITERATURE REVIEW

A. College Students' Practical Ability

Practical ability means the summation of necessary physiological and psychological features which individuals solve practical problems with existing knowledge and skills [1]. College students' practical ability is defined as comprehensive ability of students to operate and think to explore and solve problems both theoretically and practically [2], [3]. The learning contents are different among the students in different majors. So is the component of students' ability. For example, practical ability of engineering college students refers to comprehensive ability qualified for engineers in a certain field. It involves professional ability and general ability, such as team integration and cooperation ability, communication and expression ability, applying knowledge ability, research and innovation ability, engineering analysis and design ability, engineering business and management ability, engineering leadership [4]. Agricultural college students' practical ability consists of agricultural practice motivation, basic ability, special ability and situational ability [5].

Given major differences, college students' practical ability can be summarized as general practical ability such as environmental adaptability, communication and expression ability, and team cooperation ability, etc., professional practical ability by professional standard and training goal, and comprehensive practical ability such as operational ability and problem-solving ability, and so on [6], [7]. As for general and comprehensive practical abilities, different majors share common characteristics. College students majoring medical, education, management and engineering, for instance, should have the abilities of team cooperation, communication and expression, and problem solving. With the development of new engineering education, new medical education, new agricultural education and new liberal arts education in China [8], some majors and subjects in the universities will be optimized and adjusted. This will create new requirements and areas on college students' practical ability.

B. Evaluation of Flipped Classroom

America has been playing a leading role in the research and practice of flipped classroom. A systematic review of literature on flipped classroom presents that flipped classroom improve the students' critical thinking skills, creativity, application skills and problem-solving skills, etc. However, there are some problems such as workload increase for students and higher workload for teachers, need for technology competence of teachers and students, effects of the flipped method not long lasting, and so on [9]. Flipped

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classroom originates from elementary education. Anyway, researches on flipped classroom of higher education have been becoming more and more popular. Most of them have focused on STEM (Science, Technology, Engineering, Mathematics) education [10], and students' learning evaluation can be positive. Thus, some scholars suggest that flipped classroom should be more suitable for teaching of STEM [11].

Since 2007, flipped classroom has become a popular teaching idea or model all over the world. The influences on students' performance have attracted the attention of scholars. The students from the Faculty of Education at King Abdulaziz University in Saudi Arabia participated in the experiment of flipped classroom. The findings show that flipped classroom has a positive effect on students' creativity, especially with regard to fluency, flexibility and novelty [12]. In Universiti Sains Malaysia, most of the students' in school of pharmaceutical sciences responded positively on flipped classroom. Nevertheless, students with previous flipped classroom experiences, and students in three or four academic year refused or were reluctant to recommend flipped classroom [13]. In University of Alcalá of Spain, students in the first year joined a course named Fundamentals of computers technology, using a flipped learning approach. It was found that flipped classroom has a significant positive influence on students' cooperative competence, including interpersonal skills, critical and self-critical capacities, ability to communicate with others and work in a team [14].

Chinese studies on flipped classroom have increased rapidly in recent years. Flipped classroom has made some progress in Chinese colleges and universities. The majority of the scholars think flipped classroom offer many positive outcomes. As a whole, a lot of studies on flipped classroom focus on theoretical research while few studies draw attention to empirical research [15]. The analysis on Top 50 highly cited papers of flipped classroom in Chinese journals certifies that only fourteen percent of them come from empirical research [16]. Furthermore, previous studies usually focus on single curriculum, and flipped classroom at liberal arts education is dominated with English teaching. There are some challenges for teachers to improve students' autonomous learning [17].

III. RESEARCH HYPOTHESES

Based on previous research on flipped classroom and college students' practical ability, this study explores the factors of college students' practical ability from the perspective of flipped classroom. Taking course and major differences into account, the study analyzes general practical ability and comprehensive practical ability, including college students' communication and expression ability, analysis and problem-solving ability.

A. Video Lecture Sources

During pre-class learning stage, students must watch pre-recording video lectures. Some teachers prefer self-made video lectures because of their technical background and financial support, others are likely to use video lectures provided by online education platforms or publishing institutions. These external resources were made by

professional team. Most of external video lectures are of high quality. They are helpful for students' autonomous learning and improvement of their communication and expression ability, and analysis and problem-solving ability. Khan Academy, for example, has provided varieties of free online videos in multi-language versions to promote the development of flipped classroom around the world. An empirical study of college English flipped classroom indicates that MOOC (massive online open course) platforms and teaching materials provided by publishing institution can promote students' active learning and language proficiency, if students learn them in advance [18]. This led to the following hypothesis:

H1. Video lectures provided by professional institutions is positively associated with improvement of college students' communication and expression ability.

H2. Video lectures provided by professional institutions is positively associated with improvement of college students' analysis and problem-solving ability.

B. Learning Task Completion

In the flipped classroom, students need to complete various learning tasks, for example, watching video lectures, completing exercises, quizzes, collaborative group work, extensive reading, etc. Previous studies reported that students have to spend considerable time finishing tasks. That would be very difficult for students to learn, especially when several courses use flipped classroom. As a result, students are too busy to take on extra tasks. Sometimes, they take some measures to finish video learning before class, such as fast-forwarding videos [19]. Those students who could not allocate enough time to preview the learning materials, would not be able to discuss the content with other students in the classroom. If students could not join in-class discussion and out-of-class coaching, this will go against the improvement of their communication and expression ability, and analysis and problem-solving ability. Accordingly, we proposed the following:

H3. Completing learning tasks successfully is positively associated with improvement of college students' communication and expression ability.

H4. Completing learning tasks successfully is positively associated with improvement of college students' analysis and problem-solving ability.

C. Lecturer in Class

In flipped teaching, instructors design different teaching activities according to their teaching styles and preferences. During the interaction between teachers and students, for instance, some teachers prefer teacher-directed activities, explaining difficult contents and solving problems in the classroom. Others prefer student-directed activities, such as group discussion. Students solve problems with the help of teachers in the classroom. College students are likely to express their viewpoints and suggestions because they are active in thinking. The student-centered learning activities can improve their communication and expression ability, analysis and problem-solving ability. It is believed that flipped classroom is suitable for higher education because in-class discussion and various activities can provide opportunities for students to develop their skills such as critical thinking, creativity, communication and collaboration.

Teachers should transform classrooms into dynamic and interactive learning environments [20]. The result of college English flipped learning suggested that in knowledge internalization stage, activities which teachers encourage students to express their opinions and challenge others' viewpoints can improve students' oral expression ability and critical thinking ability [21]. Thus, we hypothesize:

H5. Students as lecturers in class is positively associated with improvement of their communication and expression ability.

H6. Students as lecturers in class is positively associated with improvement of their analysis and problem-solving ability.

D. Classroom Interactive Participation

Flipped classroom is a student-centered teaching approach. Compared with traditional teaching method, the effectiveness of flipped classroom depends on students' active participation [22]. An empirical study on a 2D animation course revealed that frequency of teacher-student interaction in experimental group is 4.39 times as much as control group, and that of student-student interaction in experimental group is 6.39 times as much as control group. Thus, the students like to actively participate in flipped classroom. More interestingly, their final grades are different. There is no significant difference between experimental group and control group in grades of objective test. However, there is significant difference in subjective test [23]. The results do not fully reflect students' learning performance since lots of factors may affect learning performance. When students participate in flipped classroom, they can improve their learning ability, e.g. communication and expression ability, analysis and problem-solving ability. This led to two further hypotheses:

H7. Active participation in class interaction is positively associated with improvement of college students' communication and expression ability.

H8. Active participation in class interaction is positively associated with improvement of college students' analysis and problem-solving ability.

before and after class.

From June to September, 2018, the study used convenient sampling to investigate the students. 461 valid questionnaires were collected. Participants were from six colleges and joined flipped learning. As shown in Table I, the questionnaire, presented in Chinese, comprised characteristics of college students, teaching practice and effectiveness evaluation. The sample consisted of 129 men (27.98%) and 332 women (72.02%). Most of the students studied social science. Therefore, there were more women than men. Most of the participants were sophomores (77.01%), since many flipped teaching courses were offered to sophomores.

TABLE I: QUESTIONNAIRE DESIGN AND BASIC INFORMATION

Survey Content	Variables	Variable Assignment	Percentage	Mean	S.D.
Students' Basic Characteristics	Sex	1=Male	27.98	1.72	0.449
		2=Female	72.02		
	Grade	1=Freshman	9.33	2.09	0.610
		2=Sophomore	77.01		
		3=Junior	8.68		
		4=Senior	4.99		
Subject	1=Science, Engineering and Medicine	37.74	1.62	0.485	
	2=Social Science	62.26			
Flipped Classroom Practice	Video Lecture Sources	1=Professional Institutions	63.56	1.36	0.482
		2=Teachers	36.44		
		1=Careful Completion	45.55		
	Learning Task Completion	2=Rough Completion	46.20	1.63	0.632
		3=Incompletion	8.24		
	Lecturer in Class	1=Teacher	28.63	1.88	0.659
		2=Student	55.10		
		3=Indifference	16.27		
Classroom Interactive Participation	1=Active	67.25	1.33	0.470	
	2=Passive	32.75			
Practical Ability Evaluation	Communication and Expression Ability	1=Unchangeable	18.44	1.96	0.571
		2=Somewhat Improved	67.25		
		3=Significantly Improved	14.32		
	Analysis and Problem-Solving Ability	1=Unchangeable	24.08	1.89	0.604
		2=Somewhat Improved	62.47		
		3=Significantly Improved	13.45		

IV. RESEARCH METHOD

A. Data Collection and Participants

This study was conducted in a public university with approximately 21,000 undergraduates in southwest China. Since 2015, the university has been conducting flipped classroom model. Over 1,000 students participated in flipped classroom, majoring in engineering, natural science, medicine, education, literature, economics and management. Courses included compulsory courses and elective courses. Instructors chose different domestic online education platforms for students to watch videos and complete learning tasks. Some teaching videos were self-made, while others were free from online education platforms. Thus, teachers asked students to watch videos and finish exercises before class. In the classroom, teachers communicated with the students to solve their problems and students presented their teamwork as well. Teachers and students normally use WeChat and instant messaging service QQ to communicate

B. Measurement

Flipped classroom can be conducive to improvement of college students' communication and expression ability. The result confirms that most of the students improve their communication and expression ability (81.56%). Meanwhile, flipped classroom can improve college students' analysis and problem-solving ability (75.92%).

V. FACTORS AFFECTING COMMUNICATION AND EXPRESSION ABILITY

A. Model Test

The data were analyzed by SPSS. The study applied ordinal multi-classification logistic regression model to analyze the influencing factors on college students' practical ability. Firstly, model fit and applicability were tested [24]. The result showed the fitting was good ($\chi^2=77.284, P=0.000$). The result of test of parallel lines suggested using ordinal

logistic process ($P=0.217>0.05$) (see Table II). Then, Table III shows the result of multicollinearity test. The tolerance was over 0.1, and variance inflation factor was less than 10. Thus, there is less possibility of multicollinearity.

TABLE II: MODEL FIT AND TEST OF PARALLEL LINES STATISTICS

Model	Model Fit		Test of Parallel Lines	
	Intercept Only	Final	Null Hypothesis	Generalization
-2 Log Likelihood	274.55	196.770	196.770	188.468
χ^2	--	77.284	--	8.302
Degree of Freedom	--	6	--	6
Significance	--	0.000	--	0.217

TABLE III: MULTICOLLINEARITY TEST

Model	Collinearity Statistics	
	Tolerance	VIF
Video Lecture Sources	0.984	1.016
Learning Task Completion	0.986	1.015
Lecturer in Class	0.974	1.027
Classroom Interactive Participation	0.974	1.026

B. Result Analysis

Table IV shows the results. Video lecture sources, learning task completion, lecturer in class, classroom interactive participation have significant effect on college students' communication and expression ability.

Video lectures made by professional institutions can significantly improve students' communication and expression ability. H1 was supported. The effect of video lectures made by professional institutions was 1.6032 times more that of self-made video lectures. Therefore, continuance use of video lectures provided by professional institutions is one of the important factors for improvement of college students' communication and expression ability.

Completing learning tasks carefully can significantly improve students' communication and expression ability. H3 was supported. Thus, students should spend more time and energy studying autonomously. The effect of careful completion was 5.8709 times more than that of incompleteness. Perfunctory students had no significant improvement.

Teachers acting as lecturers in class can significantly improve students' communication and expression ability. H5 was not supported. Specifically, the effect of teachers acting as lecturers in class was 1.7507 times more than that of students as lecturers. Students acting as lecturers had the effect on improvement of communication and expression ability, but not significant. Since most of the students may not be familiar with flipped classroom model, they lack relevant experiences so as to affect learning effectiveness. Nevertheless, teachers can motivate students' learning interests to participate in collaborative discussion and improve their communication and expression ability.

Students participating in classroom discussion actively can significantly improve their communication and expression ability. H7 was supported. Compared with passive participants, the effect of active participants were 2.872 times more than passive ones. The result shows that students accept mutual communication between teachers and students, and communication among students. Hence, interactive communication in the classroom is one of the important

influencing factors for improvement of college students' communication and expression ability as well.

TABLE IV: FACTORS AFFECTING COMMUNICATION AND EXPRESSION ABILITY

Variables		Estimated Value	Standard Error	Wald Value	P Value	OR
Communication and Expression Ability	Unchangeable	0.704*	0.400	3.105	0.078	2.0218
	Somewhat Improved	4.502***	0.467	92.889	0.000	90.1973
Video Lecture Sources	Professional Institutions	0.472***	0.212	4.983	0.026	1.6032
	Teachers	0 ^a	--	--	--	--
Learning Task Completion	Careful Completion	1.770***	0.384	21.201	0.000	5.8709
	Rough Completion	0.579	0.370	2.445	0.118	1.7843
Lecturer in Class	Incompletion	0 ^a	--	--	--	--
	Teacher	0.560*	0.318	3.098	0.078	1.7507
Classroom Interactive Participation	Student	0.360	0.289	1.555	0.212	1.4333
	Indifference	0 ^a	--	--	--	--
Classroom Interactive Participation	Active	1.055***	0.223	22.311	0.000	2.8720
	Passive	0 ^a	--	--	--	--

Notes: ①***, **, * show significance at 0.01, 0.05, 0.1 level; ②a: This parameter is redundant, so it is set to zero.

VI. FACTORS AFFECTING ANALYSIS AND PROBLEM-SOLVING ABILITY

A. Model Test

Model fit and test of applicability are shown in Table V ($\chi^2=70.093, P=0.000$). The fitting was good. The result of test of parallel lines showed the usage of ordinal logistic process ($P=0.887>0.05$) (see Table V).

TABLE V: MODEL FIT AND TEST OF PARALLEL LINES STATISTICS

Model	Model Fit		Test of Parallel Lines	
	Intercept Only	Final	Null Hypothesis	Generalization
-2 Log Likelihood	259.171	189.078	189.078	186.749
χ^2	--	70.093	--	2.329
Degree of Freedom	--	6	--	6
Significance	--	0.000	--	0.887

B. Result Analysis

The results show support for hypotheses 2, 4, 6 and 8 (see table VI). Video lecture sources, learning task completion, lecturer in class, classroom interactive communication have significant effect on college students' analysis and problem-solving ability.

Video lectures provided by professional institutions have a significant influence on improvement of college students' analyzing and problem-solving ability. H2 was supported. Video lectures made by professional institutions gained popularity as favorite among students. The effect of these video lessons was 1.667 times more than that of self-made ones.

Completing learning tasks carefully can significantly improve students' analysis and problem-solving ability. H4 was supported. As task completion ratio falls, OR value decreases from 5.9417 to 2.1946, meaning the reduction of probability in competence improvement. As long as students can complete learning tasks successfully, they can improve their analysis and problem-solving ability significantly.

Students acting as lecturers in the classroom can

significantly improve their analysis and problem-solving ability. H6 was supported. Furthermore, teachers acting as lecturers have more impact on ability improvement. Since teachers guide and help students to finish tasks, students can gain an in-depth understanding of learning tasks. Thus, their analysis and problem-solving ability can be improved significantly.

Students participating in discussions actively have significant improvement on their analysis and problem-solving ability. H8 was supported. The effect of active participants was 2.1968 times more than that of passive participants. Learners' discussion and interactions between teachers and students can solve the problems in preview activities. At the same time, they can encourage students' further exploration and study. Hence, active participation in classroom discussion can improve students' analysis and problem-solving ability greatly.

TABLE VI: FACTORS AFFECTING ANALYSIS AND PROBLEM-SOLVING ABILITY

Variables	Estimated Value	Standard Error	Wald Value	P Value	OR	
Analysis and Problem-Solving Ability	Unchangeable	1.211***	0.402	9.091	0.003	3.3568
	Somewhat Improved	4.617***	0.461	100.480	0.000	101.1900
Video Lecture Sources	Professional Institutions	0.511**	0.205	6.232	0.013	1.6670
	Teachers	0 ^a	--	--	--	--
Learning Task Completion	Careful Completion	1.782***	0.375	22.595	0.000	5.9417
	Rough Completion	0.786**	0.365	4.623	0.032	2.1946
Lecturer in Class	Incompletion	0 ^a	--	--	--	--
	Teacher	0.799***	0.309	6.712	0.010	2.2233
Classroom Interactive Participation	Student	0.486*	0.279	3.038	0.081	1.6258
	Indifference	0 ^a	--	--	--	--
Classroom Interactive Participation	Active	0.787***	0.211	13.929	0.000	2.1968
	Passive	0 ^a	--	--	--	--

Notes: ①***, **, * show significance at 0.01, 0.05, 0.1 level; ②a: This parameter is redundant, so it is set to zero.

VII. DISCUSSION AND IMPLICATIONS

This study contributes to the empirical results regarding flipped classroom in Chinese universities. The study shows that flipped classroom can improve college students' practical ability. The data indicate that influencing factors such as video lecture sources, learning task completion, lecturer in class and classroom interactive participation, have significant effect on improvement of students' communication and expression ability, and analysis and problem-solving ability. Hence, colleges and universities should motivate and support teachers to implement flipped classroom. Teachers should change traditional teaching methods and explore flipped classroom as well.

First, colleges and universities should provide supportive resources, such as teaching resources, financial support, and training courses, to motivate teachers to implement flipped classroom. Especially for teachers with traditional teaching experience and using intention for flipped classroom, school administrators should provide intrinsic and extrinsic motivation to enhance flipped classroom, so that teachers become more willing to implement flipped classroom and make more effort in flipped classroom. Meanwhile, universities should update their teaching resources, like video

lectures, MOOC platforms, and supplementary materials, to support flipped classroom. In some remote areas, universities should build information infrastructure and ensure every student to have access to broadband internet, thus students can watch video lectures and supplementary materials. Sometimes, school managers should reduce class size to implement flipped classroom, since group discussion can be performed effectively in small class size.

Second, teachers should stimulate students' curiosity. Usually, college students are curious about new things. They are likely to have a try. Accordingly, they are willing to accept flipped classroom. Teachers should exploit the opportunity to motivate their curiosity and improve their interests at flipped classroom. Considering different requirements on discipline construction, such as engineering, medical, agricultural, and liberal arts education, teachers should choose suitable courses to implement flipped classroom. Such courses can be distributed in different learning stages to mitigate students' study load. In the process of implementing flipped classroom, teachers should encourage students to take fully use of various learning resources to develop self-learning. For instance, students can watch video lessons in MOOC platforms and other accessible content resources outside class, think and ask questions during the discussion. Then, teachers should guide and promote students to actively participate to improve their practical ability.

Third, teachers should modify teaching design and implementation. Teachers should redesign teaching content before, during, and after class, depending on the demand of different subjects, majors and courses. When they design preview activities, they must select and integrate teaching materials carefully. They can collect legal educational resources on the Internet, like videos, supplementary reading, and exercises. They can also record video lectures by themselves, thus post-editing and processing are needed to improve self-made video quality. For students with the habits of passive learning and lack of technical skills, teachers should prepare learning guidelines to help them concentrate on self-learning. When teachers design classroom activities, they should create interactive learning environment for more students to communicate, cooperate, and present themselves. For after-class activities, teachers should focus on learning feedback and coaching. More importantly, teachers should select and assess teaching effectiveness so as to modify video lessons, lecturers, and curricular activities.

Last, a new teacher-student relationship should be built. In the flipped classroom environment, traditional teacher-student relationship can be turned into mutual learning relationship between teachers and students [25]. In the self-learning process, students are capable of obtaining various learning materials besides video lectures. In the classroom and after-class coaching, teachers often discuss with students instead of teacher-centered learning. Consequently, teachers should transform traditional ideas into mutual learning relationship between teachers and students. On one hand, teachers should redesign instructional content depending on characteristics of students and courses. Group discussion, laboratory experiment, problem-based learning and cooperative learning can be taken in the classroom to motivate students' interests, and conduct them

to participate in flipped classroom. On the other hand, students should turn passive learning into active learning, and make their effort to participate in out-of-class and in-class activities. They must try their best to improve their communication and expression ability. During the interactive learning activities, students raise the questions, discuss with their peers and teachers, and find the solutions to the problems. It is convenient for students to express their viewpoints and thought in flipped classroom. Mutual teacher-student relationship can be conducive to improving students' practical ability.

A limitation of the study is that all the participants were from the same university. The number of participants was limited. Students' learning performance ought to be investigated in a broader range and more diversified background. Another limitation is that many courses were conducted in a single semester. Teachers and students were not familiar with flipped classroom. The results of flipped classroom need to be explored further. Future research might focus on more students in different universities, and also investigate how teaching behaviors could affect students' learning effectiveness.

CONFLICT OF INTEREST

This study was carried out without a conflict of interest.

AUTHOR CONTRIBUTIONS

Lin Li conducted the research; Yi Wang analyzed the data. Both authors wrote the paper and they had approved the final version.

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