

# Feedback Mechanism Construction of Problem-based Learning Teaching Approach in Cartography Course

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## Abstract

Teaching system is based on the feedback. The internal function of a logical teaching system is monitored and regulated by the feedback. Constructing the feedback mechanism of teaching approach and making use of the feedback information to improve teaching effect are urgent problems of cartography course. Construction method is proposed and implemented based on feedback principle of automatic control theory in Problem-based Learning (PBL) cartography course teaching for improving teaching approach. The results show that the feedback mechanism is helpful for finding the positive feedback and negative feedback from teaching approach to provide the basis for improving teaching approach.

**Keywords:** Cartography; feedback mechanism; teaching approach; Problem-based Learning; Chi-square test

## 1. Introduction

Cartography is the science of the abstraction, generalization and transition about the geospatial information. Ever since 1990s, with the development of information science, cartography has undergone a drastic progress in theoretical foundation, manufacture technology and

application method, and accordingly many teachers made teaching reforms in the cartography course so as to fit in with the development in science and technology and to satisfy the demands from the social requirement. For example, Yin Zhangcai proposed his cartography teaching approach based on the discipline platform of the resource and environment science[1]. Fang Gang analyzes the construction of Cartography course as a province-level Top-quality course[2]. The traditional refining of teaching approaches start from the principal parts like textbook system, teaching material and teaching methods[3-5]. Less emphasis was put on the feedback mechanism, from which limited information was acquired from students' exercises, experiments, meetings and talks and hence teachers could hardly modify the refined teaching methods intentionally and systematically. Therefore, setting up a feedback mechanism in teaching approach and making use of the feedback information to improve teaching effects are urgent to cartography course. By introduction of the feedback in the automatic control theory to PBL cartography course teaching, this paper proposes and also implements a new teaching approach: the construction of feedback mechanism in cartography course. The results indicate that this feedback mechanism contributes to the posi-

tive and negative feedback in the implementation of the teaching approaches and that this mechanism can serve as a foundation to support the improvement of teaching approaches.

## **2. Construction of the feedback mechanism in PBL cartography teaching**

### **2.1. PBL cartography teaching**

Traditionally, the teaching of cartography used to adopt the "teacher-centered, lecture-oriented" approach. The experiment teaching sessions are implemented after an independent theoretical teaching session. Students complete experiment as what the experiment guidebook requires. After the course is finished, students will have an examination together. However, this approach is problematic now that it makes students tend to be passive; theory teaching outweighs practice in assessment; the experiment results are not satisfactory.

In view of the mentioned problems, we followed the PBL approach in cartography course, which originated from 1950s in the field of medical teaching, which valued the complicated yet meaningful problem contexts. Different from the traditional teaching approach, PBL emphasizes an investigative teaching pattern with the students being as the center to "raise a problem--collect information--discuss--summarize and reflect". The students can learn the scientific knowledge hidden behind the problem and improve their problem-solving skills and self-study ability by cooperating with others to solve real problems so as to help them solve their problems successfully, collaborate better, manage their time effectively, acquire and evaluate data and improve their self-study ability[7]. Therefore, PBL outstands its teaching principle as "task-based, teacher-led, student-centered". Based on the above, we proposes the

four-step approach in the cartography course: raise a problem--collect data--discuss--summarize and reflect".

- In respond to the four steps in the traditional approach, we design four tasks throughout a whole semester in the form of projects which requires students to accomplish within a team in a long period.
- All teams have the identical task, so to learn how to collect data is their urgent problem too. The teacher should provide the students with corresponding study materials, teach them how to make full use of the resource available in the school and how to look up them. This is very difficult to be achieved in traditional approaches.
- Organize students to introduce the solutions or achievements of their teams respectively and then ask students to think about some questions. After a period of positive thinking, the teacher should encourage students to discuss the answers with the teachers.
- A summary and reflection after a teaching session require not only all the students but also a specific team to know alternative solutions or deep questions about some specific solution.

### **2.2. Construction of the feedback mechanism**

The feedback principle is the basic principle in automatic control theory. All the systems can't control effectively and achieve the objectives until the information is fed back and a closed circuit is completed. "Feedback" actually refers to the process that the output data from a system is sent back to the input end and compared with the input data then. Feed-

back consists of positive feedback and negative feedback. Positive feedback means that the results favored the process, i.e., the products of reaction can promote the reaction in turn; feedback does not restrict the controlling part, but promote and reinforce the controlling part. Negative feedback means that the results restrain the process, i.e., the products of reaction can restrain the reaction; feedback is opposite to the controlling part, hence, the effect that controls the data could be corrected. From the perspective of system theory, teaching is a system consisting of teacher, student, teaching material and teaching approaches (including teaching methods, techniques and teaching equipment). As a system, teaching system covers feedback too. Feedback is the basis of the teaching system management. A logical teaching system can observe and regulate its inner functions on the basis of feedback. Teacher is the controlling part. During the teaching course, a teacher outputs knowledge data as well as controlling data. As the controlled part, students react to the mentioned data in an external form and feed them back to the teacher. This is the feedback of learning to teaching. A respectable use of feedback can help teaching go at its best to achieve the best teaching effect. Otherwise, it can reduce the function of the teaching system[6].

Based on the advantages of teaching system and considering all the implementation characteristics of the new teaching approach in cartography course, this paper designs the following feedback mechanism in teaching cartography course in Fig.1:(1) setting down the teaching objectives. To assign self-study-based projects to students so as to summarize the major knowledge points; (2) designing assessment index. To set up a multi-dimensional assessment index by taking students as the main body and focusing on new teaching approaches should be

designed;(3) designing questionnaire. Design a questionnaire on the basis of assessment index; (4) implementing questionnaires. Acquire statistic figures by analyzing the respondents' personal data; (5) improving the teaching approaches. To improve teaching approaches according to the feedback results; (6) perfecting the feedback mechanism of the teaching approaches.

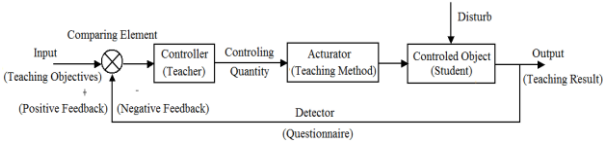


Fig. 1: The feedback control of teaching approach in cartography course

### 3. The study of the feedback mechanism of teaching cartography

#### 3.1. Methodology

In order to timely obtain students feedback on PBL teaching approach, this questionnaire chooses student of Grade 2008 and 2010 by the end of the cartography course. There are altogether 81 respondent students. When the questionnaire is collected, the data concerned is input to SPSS. For the convenience of data input, all long questions are abbreviated in short nouns. Table I shows the questions list.

After processing the questionnaire, this paper works out some simple statistics figures in three dimensions: students' acceptance to teaching approaches, existing problems and assessment methods. As shown in Table II , the level of respondents' acceptance to the teaching approaches are presented in the form of median; as to students' existing problems and assessment methods, the relevant statistics are based on the frequency of a certain option in the questionnaire and presented in the form of percentage in Table III and IV.

As shown in Table II and III, the students prefer new teaching approaches. So they wish the percentage of the assessment results could be less than 50%; Students of two grades have more common questions such as "more inertia less initiative" during the course of study and "too many knowledge points in the exercises and too demanding requirement"; most students of two grades don't prefer self-study based on written examination.

TABLE I. THE QUESTIONS LIST

Class	Label	Questions
The level of acceptance of the teaching	Approach preference	Which teaching approach do you prefer? PBL or traditional approach?
	Level of help	Do you think self-study teaching is helpful to improve one's self-study ability and broaden the knowledge widely and deeply? If yes, how helpful do you think it may be?
	pressure	Compared with traditional teaching approach, how much pressure do you have in self-study teaching?
	Percentage of result	What do you think should be the appropriate percentage of self-study result in the total course evaluation result?
	attitude	Do you agree that after this course, you begin to know your own shortcomings in initiative study?
	Quantity of Projects	How many projects can you take in?
Existing problems	Existing problems	What key difficulty do you have in finishing the projects?
Assessment methods	Assessment methods	What do you think is an appropriate method to evaluate your self-study?

Students can accept the introduction of PBL teaching approach and even benefit from PBL. Most of them can find their inertia in study and incapability in finishing high-integrated self-study projects. In

terms of assessment methods, they showed more requirements in diversification.

### 3.2.2 The Differences of students' basic data

Now that the questionnaires are conducted among two different grades with different teaching approach preferences, the paper analyzes the differences in the level of help, pressure, percentages of results, attitude and comprehensive exercises in Table V. According to the characteristics of the distribution of the figures, the author adopts the nonparametric chi-square test.

TABLE II. THE LEVEL OF RESPONDENTS' ACCEPTANCE TO THE TEACHING APPROACHES

Item	median
Preference of the Approaches	2.00
Level of Help	3.00
Pressure	3.00
Percentage of Results	2.00
Attitude	3.00
Number of Task	3.00

The statistic tests shows that level of help, pressure, percentage of results, attitude and comprehensive exercises didn't show a significant difference among the two different grades, which indicates that students of different grades show no significant difference in accepting new teaching approaches. Admittedly students of grade 2010 have a higher level in projects than students of grade 2008 because they have to do more literature search job and allocate more time than students of grade 2008. However, students of two grades share similar acceptance to new teaching approach.

TABLE III. EXISTING PROBLEMS OF ALL STUDENTS

Existing Problems	2008	2010
Too many knowledge points, less and too demanding requirements	46.4	42.3
literature search is too difficult	32.1	36.5
Inertia and less motive in self-study	67.9	48.1
Untimely instruction from teachers	0	7.7
Not enough time	7.1	11.5
Bad teamwork, no organizer in self-study	10.7	23.1

Note: this question is a multiple-choice question and statistics refer to the percentage that the respondents of the horizontal line choose the options of the vertical line

TABLE IV. STATISTICS OF ASSESSMENT OF THE TEACHING APPROACHES THAT STUDENTS CHOOSE

The form of self-study assessment	2008	2010
Term paper and report	40.7	28.3
Written test	7.4	5.7
Oral test	22.2	28.3
discussion	29.6	28.3
Mutual test within teams	18.5	26.4

Note: this question is a multiple-choice question. The statistics in the table refers to the percentage that all the respondents choose the option in the vertical line.

TABLE V. THE  $\chi^2$  TEST STATISTICS OF THE QUESTIONNAIRES IN DIFFERENT TEACHING APPROACH PREFERENCES AND DIFFERENT GRADES

Item		Teaching Approach Preference	Grade
Level of help	$\chi^2$	14.10	1.11
	Sign	0.0009**	0.5716
Pressure	$\chi^2$	13.80	5.21
	Sign	0.0031*	0.1565
Percentage of results	$\chi^2$	21.89	6.37
	Sign	0.0001**	0.0945
Attitude	$\chi^2$	4.91	2.53
	Sign	0.1781	0.4681
Quantity of projects	$\chi^2$	2.89	1.59
	Sign	0.4076	0.6599

Note: \* $p < 0.05$ , \*\* $p < 0.01$

Besides, students who prefer different teaching approaches have no significant differences in attitude and comprehensive exercise quantity, but in level of help, pressure and percentage of results. This is closely related to students' experience in self-study. Table VI and VII show that students who prefer traditional approach think that the major problems are "more inertia, less motive in self-study" and "difficulty in literature searching" and that the best way to evaluate the result of self-study is "discussion" and "mutual assessment inside the team". As to students who prefer new teaching approach, they think the major problems are "more inertia, less motive in self-study" and "too many knowledge points and demanding requirements" and that the best way to evaluate the result of self-study is "term paper or report" and "oral examination".

TABLE VI. THE EXISTING PROBLEMS OF STUDENTS WITH DIFFERENT TEACHING APPROACH PREFERENCES

Existing Problems of Students	Preferences of Teaching Approaches	
	Traditional	PBL
Too many knowledge points, less and too demanding requirements	26.7	47.7
literature search is too difficult	46.7	32.3
Inertia and less motive in self-study	53.3	55.4
Untimely instruction from teachers	0	6.2
Not enough time	20.0	7.7
Bad teamwork, no organizer in self-study	20.0	18.5

Note: this question is a multiple-choice question. The statistics in the table refers to the percentage that all the respondents choose the option in the vertical line.

TABLE VII. THE FEEDBACK TO SELF-STUDY ASSESSMENT FORMS FROM STUDENTS WITH DIFFERENT TEACHING APPROACH PREFERENCES

Self-study Assessment Forms	Preferences of Teaching Approaches	
	<i>Traditional</i>	<i>PBL</i>
Term paper and report	20.0	35.4
Written test	6.7	6.2
Oral test	13.3	29.2
Discussion	40.0	26.2
Mutual assessment with team	33.3	21.5

Note: this question is a multiple-choice question. The statistics in the table refers to the percentage that all the respondents choose the option in the vertical line.

Therefore, the causes of significant differences in level of help, percentage of result and pressure are as follows:

(1) Difference in self-study ability. Students who prefer traditional approach are less proficient in literature search than students who prefer self-study approach. When facing a trouble, they can hardly bear it. So they anticipate a help from other students in a discussion to finish the exercises; Students who prefer self-study are more confident. So they expect a lower integration level in exercises and are more willing to pass the assessment by term paper or report.

(2) Difference in study initiative. Due to the insufficient preview and perpetration, students can't organize a good discussion or oral exam. The oral exam only works among student whose team needs to give an oral presentation while the rest students are passive in oral activity. Hence, we can infer that students with different preference in teaching approaches have significant differences in level of help, percentage of assessment result and pressure. Those who prefer traditional teaching approach are weak in self-study ability. Also due to the lack of study initiative, they find less level of help in self-study, which less to great pressure and expectation of decrease of

the percentage of self-study assessment in the total result.

#### 4. Conclusion

Feedback is the foundation of teaching system. A reasonable teaching system can monitor and regulate all its inner functions on the basis of feedback. Teachers in this teaching system are more listeners of students' feedback than knowledge transmitters. When helping solve students' study problems, teachers also need to teach students the way of self-study because traditional teaching approach can't retrieve student's feedback data in their way of study. This paper introduces the feedback principles of automatic control theory to the PBL cartography course teaching and constructs a feedback mechanism in teaching approach. By questionnaires, this paper conducts an empirical research. The results show that the feedback mechanism can contribute to analyzing the effect of the new teaching approaches in a quantified way.

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