PRACTICE AND EVALUATION OF STATISTICS AN INTRODUCTORY LECTURE ON PEER INSTRUCTION

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ABSTRACT

"Basic knowledge of mathematics and science and expertise as a technician" is cited as one of "knowledge, skills, and attitudes required for engineers who will be responsible for the future" in CDIO syllabus, and CDIO Standard 8 Active Learning ", which is a framework for training engineers consisting of 12 standards. We have practiced introductory statistics lecture using Peer Instruction (PI) which is one of active learning methods. PI has many conceptual problems developed in physics and many practical examples. In mathematics, however, conceptual problems are extremely small, so we have gathered together among faculty members to analyze the results of implementation of PI, develop and improve mathematical conceptual problems, and strive to improve teaching ability among teachers (CDIO Standard 10). Also, as a feature of PI, it is said that general teachers can easily practice active learning in regular classrooms, so we expect to contribute to the further development and popularization of CDIO.

KEYWORDS

ActiveLearning, Peer Instruction, mathematical Concept Question, Standards:8, 10.

INTRODUCTION

At recent universities, the shift from "one way class" to "interactive class" based on the traditional lecture form is progressing. "Interactive class" is a form of class focusing on the interaction between teachers and students and students. Examples include "workshop type lesson" By Laws (1997). And "peer instruction (PI)" by Mazur (1997). PI is a kind of active learning type lesson form incorporating discussion between students. According to the words "peer: student-to-student" and "instruction: teach each other", teaching among students is the essence of PI, and it is characterized that students themselves actively make corrections of misunderstandings and deepening concept understanding. Teachers present "conceptual problems" to students and urge students to discuss. PI and conceptual problems have already been achieved in physics subjects. We are expected to develop mathematical conceptual problems and lead students to a more intriguing understanding of mathematical concepts by applying PI. So we started to create mathematical conceptual problems and introduce active learning by Peer Instruction (PI) in mathematics priming subjects (CDIO Standard 8). Also, at the end of the term, faculty analyzes PI practice results, create and improve conceptual

problems, and strive to improve teaching ability among teachers (CDIO Standard 10). In the small sentence, report, part of the practical result in the introductory statistics lecture, which the first author was in charge.

USE OF CLICKER, PROCEDURE OF PEER INSTRUCTION

An overview of the clicker system used in this practice is shown in Figure 1. Distribute Clicker (remote controller) to each student. The teacher PC equipped with the receiver which receives the signal from the clicker has three roles:

- Role to present a problem and answer choices to students at the projector,
- Role of collect answers from students,
- Role to feed back the aggregate result of answers from the projector.

Although the use of clickers is not essential in PI, there are advantages such as aggregation of students' answers and easier analysis of lesson effect by using Clicker, which is compatible with PI (described later). The procedure of PI in this practice is as follows (1) to (5). We will call this series of procedures "unit" in the lower case. The execution time of one unit was about 10 to 15 minutes, and the number of execution units per class (90 minutes) was generally within 4 to 5 pieces.

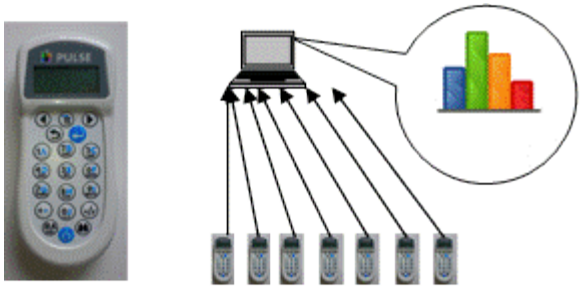

Figure 1 Overview of clicker system

(1) Explanation of learning materials by writing on blackboard
(2) Presentation of answer choices (before discussion), "voting" using clickers, feedback of counting result
(3) Discussion among students on answer choices
(4) Re-presentation of answer choices (after discussion), "voting" using clickers, feedback of counting result
(5) Presentation and explanation of correct answer

In PI, the discussion in (3) is important, and the understanding of students changes dramatically before and after that. The situation is immediately transmitted to the entire classroom at (2), (4). In the clicker system, it is possible to instantly totalize and display the distribution of students' responses. It is also a great advantage that students can understand the degree of understanding of students in (2) and (4) in this way and it becomes easier for teachers to develop lessons in accordance with their degree of understanding.

Although the teacher is involved in the teaching with the writing on the blackboard of (1) and the presentation / explanation of the correct answer of (5), the teacher does not intervene in the content of the discussion between (3) students, leaving it to the discussion among the students. However, we advised on appropriate discussions such as "Please state the basis of your answer and let the other party understand" and devised so that students can discuss it smoothly.

Presentation of alternative answer choices in (2) and (4) presents the same problem. We prepared a problem asking conceptual matters. If understanding degree in (2) is low, learn

deeply in the discussion of (3) and try to formulate the concept of mathematics. If it is judged that the degree of comprehension of (2) is sufficiently high, omit (3) and (4) and proceed to the next problem.

ADVANTAGES OF CLICKER SYSTEM IN PEER INSTRUCTION

Although the use of clickers is not necessarily required in PI, clickers have three major advantages:
(1) Immediate nature of aggregation / feedback:
The clicker system can instantly tabulate the answers of students and can immediately present the response distribution status of all the members on a slide so that the classification result can be shared throughout the class. It is also interesting for teachers, as students receive surprising responses, such as when a student answers are divided.
(2) Traceability of individual answer history:
Since each clicker can be associated with an individual student, the response history for each individual can be saved. Therefore, it is also possible to perform detailed comparative analysis with changes in answer patterns for individuals, calculations in regular tests, and description problems.
(3) Anonymity of personal answer:
"What you answered" is not known to identify students, so it is easy to answer honestly. Therefore, it is considered that more accurate data can be collected by clicker system.

IMPLEMENTATION RESULT

Introductory lecture on statistics at the Kanazawa Institute of Technology in charge of the first author, PI and clicker were introduced from the first semester 2016 and urged students to learn each other. The answer choice problem used in this practice was developed by the authors jointly.

Problem example

Figure 2 asks the shape of the graph of the distribution function $F(x) = \sum_{t \leq x} f(t)$ from the probability function $f(x)$ of the discrete probability distribution and contains the conception of "to accumulate probability values" as a component. Since the value in Figure 2 is monotonically increasing, the correct answer is No. 3. The top row of the table is the distribution of responses before the discussion and the bottom row is the distribution of responses after discussion.

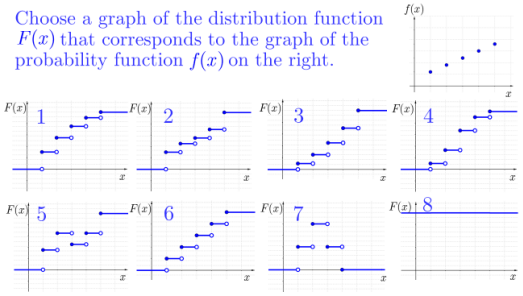

Figure 2. Answer choice problem and answer situation (probability distribution function)
Note: The problem slide is referenced in Taniguchi, Nishi, Kudo, & Yamaoka (2017)

Table 1. Results of Figure2.

Answer number	①	②	③	④	⑤	⑥	⑦	⑧
Before discussion	5.5%	0.0%	**63.6%**	3.6%	0.0%	25.5%	0.0%	1.8%
After discussion	3.6%	1.8%	**87.5%**	0.0%	1.8%	3.6%	0.0%	1.8%

RELEVANCE TO FINAL EXAMINATION

Data comparing the results of the final examination of the statistical introductory lecture (lecture until the first step of the inferential statistics) that the first author was responsible for the first semester of 2015 (before introduction of PI) and the first semester of 2016 (after introduction of PI) quoted from the reference Taniguchi, Nishi, Kudo, & Yamaoka (2017)

a) Probability calculation Trend of correct question rate: 46% → 65%

b) Reverse lookup the normal distribution table Problem Trend of correct answer rate: 23% → 84%

c) Finding the rejection region of t-test Trend of correct answer rate: 10% → 25%

The calculation of the two-tailed t-test showed that this change was statistically significant at the $p = 0.05$ level for b) and c), and the correct answer rate is considered to be improving (Software used: Microsoft Excel 2010 analysis tool "t-Test: two-sample test assuming that variances are not equal ").

Next, we compare the final examination of the first semester of 2016 in the first year of PI introduction and the final examination the first semester of 2017. Both classes are in charge of the same grade of the same undergraduate division, in particular the number of questions and the range of examinations for final examinations are aligned in both academic years, and the textbooks and learning process used are the same. The average of the final examinations of both years was higher in 2017. The calculation of the two-tailed t-test for the final examination results of both years showed that this change was statistically significant at the $p = 0.05$ level. About this result, we believe that it is because the explanation by writing on the blackboard after class start and the selection order of problem slides are made smoother.

Table 2. Comparison of final examinations (previous term of 2016 · 2017)

t-Test:Two-Sample Assuming Unequal Veriances		
	2016	2017
Mean	65.44262295	72.38596491
Variance	334.384153	357.9197995
Observations	61	57
Hypothesized Mean Difference	0	
df	115	
t Stat	-2.024633368	
P(T<=t) one-tail	0.022610852	
t Critcal one-tail	1.65821183	
P(T<=t) two-tail	0.045221704	
t Critical two-tail	1.980807541	

(Excel 2010 analysis tool: test with two specimens assuming that t-test variance is not equal)

CONCLUSION, FUTURE PROSPECTS

We have started to develop mathematical conceptual problems and peer instruction in mathematics priming subjects. We actually carried out peer instruction using Clicker, and got a response history of the student. Furthermore, we have conducted response survey on the likes and dislikes of mathematical physics and mini tests on probability statistics at the first lesson and last lesson in each semester to secure answer data before and after class.
In the future, I would like to continue teaching improvement activities between teachers (CDIO Standard 10), progressing active learning by PI, developing mathematical conceptual problems, and contributing to further development and dissemination of CDIO through our efforts.

ACKNOWLEDGEMENT

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