

Problem-Based Learning in Department of Mechanical Engineering

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Abstract

We have been starting the class of problem-based learning (PBL) in the department of mechanical engineering since 1995. The purpose of the chance by which PBL was started 14 years ago is to satisfy the demand of students named “I want to attend the class like the contest of the robot”. A lot of reports that students’ various abilities can be effectively improved are done as for the form of PBL recently. We started the class of two kinds of a year PBL to the students of 17-18 years old in 2007. The first term is a class of PBL which is called “Consistent method”, and the same group does the process of Plan _ Do _ Check concerning the manufacture of one work. On the other hand, the second term is a class of PBL which is called “Allotment method”, and a group different in each process manufactures one work. Students’ opinions were investigated about the class of two PBL, so we clarified that the allotment method was effective to the improvement of the communication ability.

Introduction

The investigation was done in Japan for young engineers in 2007. It was pointed out that the communication abilities of young engineers in Japan had decreased in the report. These problems are not only young engineers in Japan. The tendency to the communication abilities of young engineers are reported of similar in America and Australia.1)2) We taught PBL of a consistent method and the allotment method for 38 students of chiefly 17-18 years old who were aiming at the engineers, and investigated which was excellent about seven abilities. It has been understood that students of about 90% are feeling from the questionnaire survey executed after the classes of two PBL ends that the communication ability is improved to the allotment method.

Consistent method and allotment method

Table1 shows the relation between each process of Plan→ Do→ Check in a consistent method and three groups. The problem of a consistent method was “Manufacture the work which converted the rotation movement of the motor into a straight line movement.” àTPlanàT is a process which is designed and drafted after each student discusses the idea in the group. àTDoàT is a process where the part processing of the work and assembly are done referring to the assembly chart and the part chart. àTCheckàT is a process where the work manufactured referring to two or more drawings are evaluated. Table2 shows the relation between each process of the allotment method and three groups. The problem of the allotment method was “The ball of the glass must manufacture the work which moved in the direction of Z by 30mm or more respectively by 50mm or more in the direction of X and Y. “ And the size of the work provided for the condition within 250mm_250mm_250mm. The drawings where A group did Plan are passed to B group. The work by which A group did Plan is manufactured by B group. C group evaluates referring to the work which B group manufactured as the drawings of A group. They were ten actually groups though shown in the tables only by three groups at here.

Table1: Consistent method

Plan	Do	Check
Group A Plan A	Group A Do A	Group A Check A
Group B Plan B	Group B Do B	Group B Check B
Group C Plan C	Group C Do C	Group C Check C

Table2: Allotment method

Plan	Do	Check
Group A Plan A	Group B Do A	Group C Check A
Group B Plan B	Group C Do B	Group A Check B
Group C Plan C	Group A Do C	Group B Check C

Programs of two PBL

Table3 (a) and (b) were programs of each PBL, and either PBL was composed in 14 weeks. In the program of a consistent method in Table 3(a), the 1st~8th week are periods of Plan, and 9th~13 week are the period of Do, the 14th week is the period of Check.

Table 1(b) is a program of the allotment method. The period of two weeks was installed for succession from Plan to Do. And, three weeks were installed as a period of succession from Do to Check. The sixth week is a meeting to explain the work which students of Plan designed. At this time, students of Do should accurately understand the presented drawings. In addition, it is necessary to point out two or more bad locations which exist in the drawings to students of Plan. Afterwards, students of Plan should correct the drawings by the eighth week.

Table3: Programs of consistent method and allotment method

(a) Consistent method

Weeks	Contents	Plan/Do/Check
1	Orientation	Plan 1
2	Discuss the work in each group	Plan 2
3	Design and drafting of work(1)	Plan 3
4	Design and drafting of work(2)	Plan 4
5	Design and drafting of work(3)	Plan 5
6	Design and drafting of work(4)	Plan 6
7	Design and drafting of work(5)	Plan 7
8	Submitting of blue-print	Plan 8
9	Manufacture(1)	Do 1
10	Manufacture(2)	Do 2
11	Manufacture(3)	Do 3
12	Manufacture(5)	Do 4
13	Manufacture(6)	Do 5
14	Report meeting of works	Check

(b) Allotment method

Weeks	Contents	Plan/Do/Check
1	Orientation	Plan 1
2	Discuss the work in each group	Plan 2
3	Design and drafting of work(1)	Plan 3
4	Design and drafting of work(2)	Plan 4
5	Design and drafting of work(3)	Plan 5
6	Explanation meeting of works	Plan6/Do1
7	Submitting of blue-print	Plan7/Do2
8	Manufacture(1)	Do 3
9	Manufacture(2)	Do 4
10	Manufacture(3)	Do 5
11	Manufacture(4)	Do6/Check1
12	Manufacture(5)	Do7/Check2
13	Manufacture(6)	Do8/Check3
14	Report meeting of works	Check

Fig.1: Photograph in class of allotment method

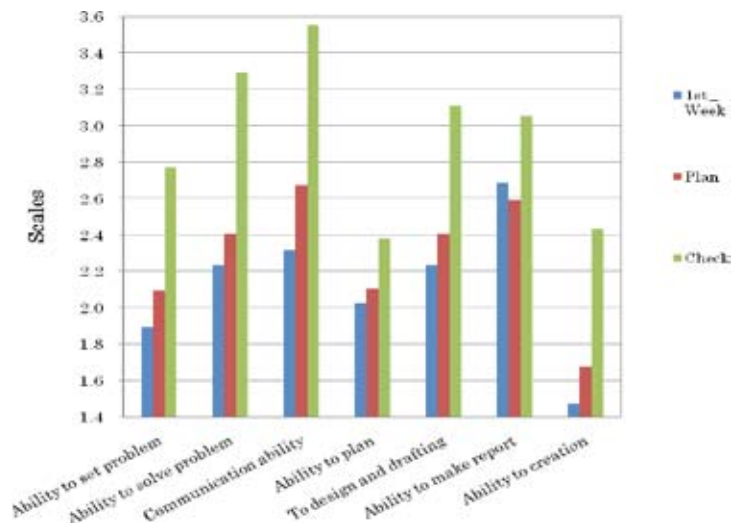


Fig.1 (a) is a photograph of the association to explain the work held on the week sixth in the allotment method. Students of Plan are explaining the works for the students of Do. Fig.1 (b) is a photograph of try the receipt of students of Do of the drawing from students of Plan, and the understanding of the drawing at the machine factory. Fig.1 (c) is a photograph to which the group of Check designs by students of Plan and is evaluating the work manufactured by students of the Do group.

Investigation concerning seven abilities

We examined the effect of the education in two PBL about seven abilities. Seven abilities are the ability to set problem, the ability to solve problem, the communication ability, the ability to plan, the abilities to design and drafting, the ability to make report, and the ability to the creation. As for seven abilities in a consistent method, Fig.2 is results of the investigation in the first week,

Fig.2: Evaluation of each student in consistent method to seven abilities



Plan (the eighth week) and Check (the 14th week). The evaluation of five stages by oneself students which is that the abilities had risen with the progress of the class were obtained about the other six abilities except the ability to make the report.

Fig.3: Evaluation of each student in allotment method to seven abilities

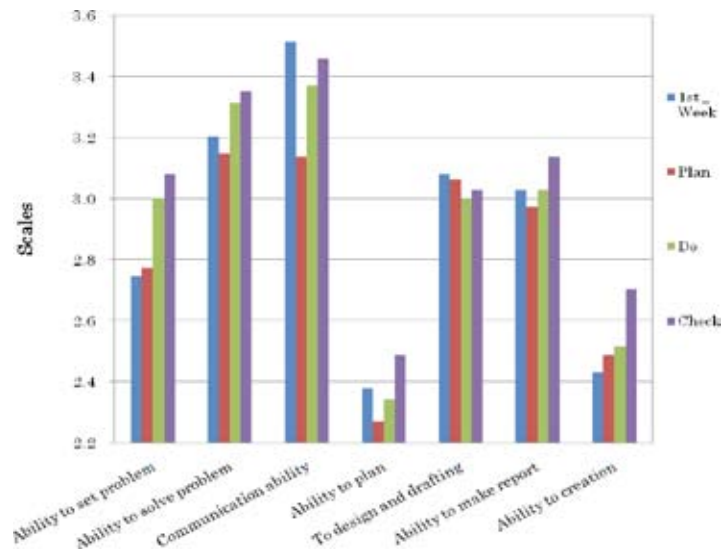


Fig.3 is an investigation result in the allotment method. In the ability to set the problem and the ability to the creation, it is understood to rise as the class advances. Moreover, it has been understood to decrease the ability to solve the problem, the communication ability, the ability to plan, and the ability to make report at 1st week → Plan7.

Students' willingness and concentrated degrees

Fig.4: Change in students' willingness

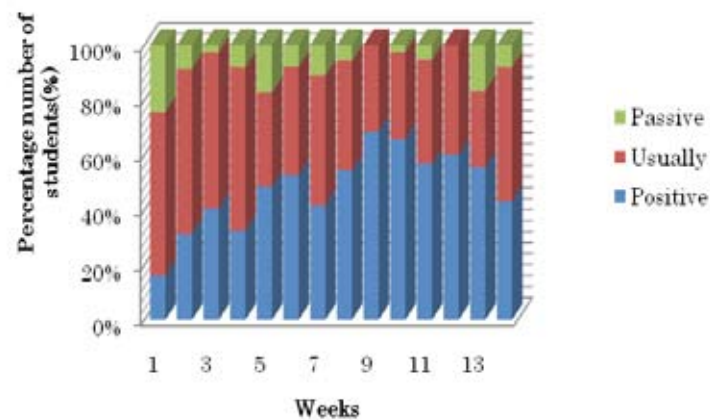


Fig.4 is a result of investigating the relation in the class of 14 weeks and students' willingness in the allotment method. When the class ended, students' willingness was self-evaluated by three stages. The content of three stages is positively and usually passive. Positive student's ratio was 18% during the first week. We think that it is a main reason that the explanation of the teacher side was long from the comment of students. The ratio decreases by about 10% on the week fourth though positive student's ratio increases in Fig.4 until 1-3 weeks. This was set at 180 minutes from the fourth week though was 90 minutes the class time of 1-3 weeks. The drawing is thought that being not able a main reason thus as it is a plan though the class time doubled from the comment of students. Afterwards, positive student's ratio has decreased during the seventh week. The reason for this cause is that students were the examination periods from the next day. Positive student's ratio was about 60% though the parts processing of the work and assembly were done in each group at the machine factory on the 8th~13th week. And, students of 40% were positive during the 14th week.

Fig.5: Change in students' concentrated degrees

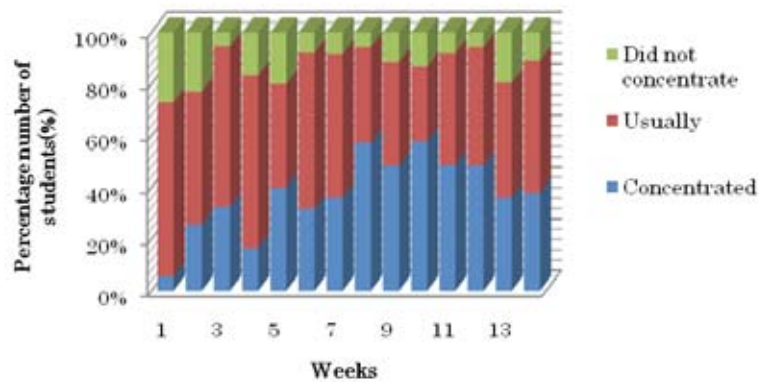
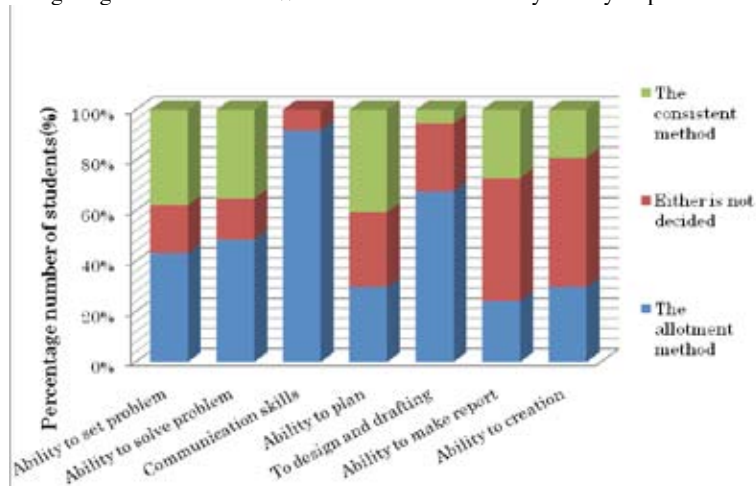


Fig.5 is a result of examining students' concentrated degrees in the allotment method. The change in the ratio of the student who had concentrated in the class has a tendency which is almost similar to Fig.4. However, the ratio of students who had concentrated has decreased during the sixth week by about 10% in Fig.5. The association to explain the work of the sixth week understands students were feeling the difficulty explain to Do as a standpoint of Plan and understand Plan as a standpoint of Do. Thus, for a lot of students to explain the drawing and to understand, it was confirmed that there was a problem in the communication ability.

Which PBL is excellent in the abilities improvement?

Fig.6: Result of investigating students about "Which is excellent so that you may improve each of seven abilities?"



"Which PBL is excellent for the improvement of your seven abilities?" was asked to 38 students who had experienced PBL of a consistent method and the allotment method. Fig.6 shows the result. The student of 92% was answered the communication ability as the allotment method. Moreover, it was answered that the allotment method was excellent to improve the ability for the student of 60% to do the design and drafting. A consistent method draws the drawing of one work in one group. However, when the necessity for understanding the drawing which other groups drew further is Do and Check, the allotment method is caused. Therefore, it can be referred that the allotment method is suitable for the communications ability and the ability's of the design and drafting being improved compared with a consistent method.

Conclusions

We examined how seven abilities were improved by using the own evaluation of students of PBL of a consistent method and the allotment method. It was confirmed that students had been feeling that a consistent method improved in all concerning seven abilities. Moreover, how students' willingness and concentrated degrees changed about the allotment method was examined, and an almost similar tendency was confirmed as for student's willingness and

concentrated degree. In addition, it was possible to make students understand the necessity for improving the communications ability and the design drafting ability to play the role as a standpoint of Plan and Do. To improve the abilities of the communications ability and the design drafting by the investigation to 38 students who had experienced a consistent method in addition to these and the allotment method, the allotment method suitable became plain.

References

01. 1. J.E.Mills and D.F.Treagust(2003), Engineering Education–Is Problem Based Or Project-Based Learning The Answer?, Australasian Journal of Engineering Education, Web page, http://www.aace.com.au/journal/2003/mills_treagust03.pdf
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