

# **Formation of Active Attitude for Learning and of Habits of Scientific Thinking by Project Based Team Learning at Kanazawa Institute of Technology**

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## **ABSTRACT**

Fundamental Laboratory for Creative Activity (FLCA) I, II and III with a style of project based team learning are set up as required subjects in freshman and sophomore year. These FLCA courses have four purposes. First is to make students understand a usual experimental process for solving a problem. Second is to make students accustom to scientific thinking and investigation of scientific journals for solving problems. Third is to make students keep a conventional style and several rules for scientific reports in their mind. Fourth is to train students for leadership and personal/interpersonal skills.

The most characteristic features of FLCA are that students can select freely a team experiment theme within familiar phenomena encountered in their daily life and must carry out their experiment by themselves. Instructors are just adviser in these courses. These are very different from usual experimental courses in which experimental themes and methods are fixed. The class consists of 140 to 280 students and 4 to 8 instructors. Each instructor takes care of 4 to 6 teams consisted of 4 to 6 students. Moreover 6 to 12 student staffs assist the class.

It was clarified from the results of the questionnaire for FLCA III that the characteristic features of FLCA were very effective for the formation of active attitude for learning and of habits of scientific thinking.

The goals to be achieved in each FLCA course, the operation of class, the support system of class and an example of experiment carried out in FLCA III were also introduced.

## **KEYWORDS**

active attitude, scientific thinking, project based team learning, support system

## **Introduction**

Institutional goal of Kanazawa Institute of Technology (KIT) is to produce “engineers who can make well-thought decisions and act on them” for the benefit of mankind. This goal means competent engineers who can find out and solve important problems by themselves. Engineers like this must have sufficient scientific knowledge, habits of scientific thinking, leadership and personal/interpersonal skills. Of course, their attitude for learning and life must be active.

It is natural that freshmen do not have sufficient scientific knowledge. However, following problems besides this are very remarkable for recent freshmen at KIT:

1. They are accustomed to be given a problem and have never found out a problem by themselves.
2. Of course, they seldom think problems scientifically and have never investigated scientific journals for solving problems.
3. Their basic knowledge of high school level in physics and chemistry is vague and they are not familiar with experiments for those.
4. They cannot take their notes adequately and cannot write scientific reports logically.

Namely, in order to learn smoothly subjects in their major area and reach the institutional goal, they need to improve their present various abilities and passive attitude for learning as soon as possible.

From these reasons, three courses called Fundamental Laboratory for Creative Activity I, II and III (hereafter FLCA I, II and III) are set up as required subjects having purposes of improvement of freshmen's various abilities and passive attitude for learning[1][2]. These courses have a style of project based team learning over 15 weeks. FLCA I and II are set up in freshman year and FLCA III in sophomore year, respectively. Accordingly, all about 3300 students in freshman and sophomore year must attend these classes.

The objective of this report is to introduce the goals, the characteristics and the operation of these courses. It has also been intended to clarify the educational effects obtained by the implementation of these courses.

### **Goals to be achieved in the each FLCA course**

These FLCA courses have four purposes. First is to make students understand a usual experimental process for solving problems. Second is to make students accustom to scientific thinking and investigation of scientific journals for solving problems. Third is to make students keep in their mind conventional styles and several rules for scientific reports. Fourth is to train students for leadership and personal/interpersonal skills. Among these, the second purpose is the most important, because such attitude is necessary for students learning at university.

In order to accomplish above four purposes, things needed for carrying out experiments and writing reports for experimental results were divided into 12 items. Moreover 12 items were divided into 3 pairs according to the grade of difficulty. Then each pair was distributed to the each course of FLCA I, II and III as the goals to be achieved by students, respectively. Furthermore, Leadership and personal/interpersonal skills are trained by the project based team learning in these courses.

Subject matters in FLCA I are the observation of the phenomenon selected as experimental theme, safety in experiments and accuracy in measurements. FLCA II is related to the design of accurate measurement method. In FLCA III, influences of various factors on the phenomenon are evaluate quantitatively.

The goals to be achieved in FLCA I is as follows:

- (1) Students can carry out experiment safely with sufficient caution.
- (2) Students can show results as values with correct units.
- (3) Students can describe observation results using both of drawing and sentence.
- (4) Students can graph experimental results and explain characteristics of results.

The goals to be achieved in FLCA II is as follows:

- (1) Students can observe and measure accurately characteristics of a phenomenon.
- (2) Students can use appropriately experimental instruments and apparatuses.
- (3) Students can describe intelligibly experimental methods.
- (4) Students can gather proper information about the experimental theme by the investigation of literatures on their experiment theme.

The goals to be achieved in FLCA III is as follows:

- (1) Students can find out the factors which influence a phenomenon and can plan the appropriate experiments to clarify the influence of various factors on the phenomenon.
- (2) Students can design proper and accurate experimental methods.
- (3) Students can apply their experience and scientific knowledge to the consideration of experimental results.
- (4) Students can make a brief report with standard style consisted of introduction, samples used and measurements, results, discussion, summary and references.

### **Characteristics and operation of FCLA courses**

The most characteristic features of these courses are that students can select freely a team experimental theme and must carry out their experiment by themselves as a rule. In this point of view, FLCA is different from usual experimental courses in which experimental themes and methods are fixed. However when considering the present abilities of students as mentioned above, the experimental themes related to familiar phenomena encountered in their daily life such as drying process of laundry, baking process of pan cake, cooking process of spaghetti etc. are recommended to students. These kinds of experiment themes work effective in the increase of students' motivation for carrying out of their experiment, because students are interested in and know well the phenomenon selected as experimental theme.

Experimental theme has to be admitted by instructors. Only simple or difficult themes are rejected at this time. Moreover, they never force experiment themes, samples to be used and measurement methods on students. Apparently instructors behave just as adviser in these courses. However, in order to guide the experiment to right direction, it is very important that they watch always progress of students' experiment and give diligently their adequate suggestions to students.

As an example, subjects and related students' activities in each week for FLCA III are tabulated in Table 1. As shown in this table, this course is divided into seven parts such as determination of team theme, establishment of experimental model, establishment of experimental and measurement methods, poster presentation for experimental method established, quantitative estimation of influences of various factors on a phenomenon, preparation of experimental report and oral presentation.

In these courses, students have usually two assignments such as drawing up of the experimental plan for next week and investigation of literatures on their experiment theme. In addition to those, student sometimes must send in the part of their experimental report such as introduction, experimental, and results and discussion. Instructors read assignments and the part of their report, give their comments to students and correct the part of their report.

The classes consist of 140 to 280 students and 4 to 8 instructors. Each instructor takes care of 4 to 6 teams consisted of 4 to 6 students. Moreover, 6 to 8 student staffs assist the class.

These large classes are managed without any difficulties by means of several systems such as a lending/return service system for experimental apparatuses and data bases of utilizable apparatuses and of basic theories of high school level in physics and chemistry[3]. This lending/return service system is the system that student staffs prepare apparatuses required for the students' experiment before the time for class, according to the request of students. Hence, students must request those by the day before their class, in order to operate smoothly this system. Maintenance, cleaning and regulation of the apparatuses and the experimental room are also student staffs' role as well as teaching students how to use apparatuses.

Team themes selected by students include many different things. Following is an example of theme in FLCA III. It is titled "Method not to Get Wet with Rain". The purpose of this team was to clarify the effect of an umbrella in rain, because they got wet with rain, even though they put up their umbrella. This team made a simple model by which rainfall could be reappeared in laboratory. Then they observed how people got wet with rain using the model and found that important 6 factors which influenced on getting wet were average rainfall, wind velocity, height and angle putting up umbrella, and size and shape of umbrella. As the results of trial and error, they made the final experimental model shown in Figure 1 in which polyurethane sponge was used as a person. This model consists of two parts such as the rainfall part which moves in connection with the moving velocity of the sponge and the rectifier part of wind. The rainfall and the velocity of wind in this model are changeable respectively. The amount of getting wet can evaluate quantitatively from the weight of rainfall absorbed in the sponge.

They carried out their experiment using this model and deduced their conclusion for method not to getting wet with rain.

Table 1  
Subjects and related students' activities in each week for FLCA III

Week	Subjects	Students' Activities
1	Determination of team theme	To determine team theme within familiar phenomena encountered in daily life through the discussion in the team.
2		
3	Establishment of reappearance of the selected phenomenon in a laboratory and observation of the phenomenon	To establish simple experimental model for the phenomenon. To clarify experimentally 6 factors which influence the phenomenon
4		
5	Test of quantitative estimation methods of influences of 6 factors on the phenomenon	To establish methods by which influences of 6 factors on the phenomenon can be estimated quantitatively. To select and prepare proper apparatuses.
6		
7	Preparation of poster presentation	To prepare the poster for presentation after summarizing results.
8	Poster presentation	To consider improvements of experimental methods through discussions for useful comments in the poster presentation.
9	Quantitative estimation of influences of factors on the phenomenon by means of the improved experimental method	To estimate quantitatively influences of factors on the phenomenon after confirming the reappearance of the phenomenon and the precision of measurement values for the improved experimental method.
10		
11		
12		
13	Preparation of the experimental report	To prepare the experimental report consisted of introduction, experimental, results, discussion, summary and references.
14		
15	Oral presentation	To listen to presentations.

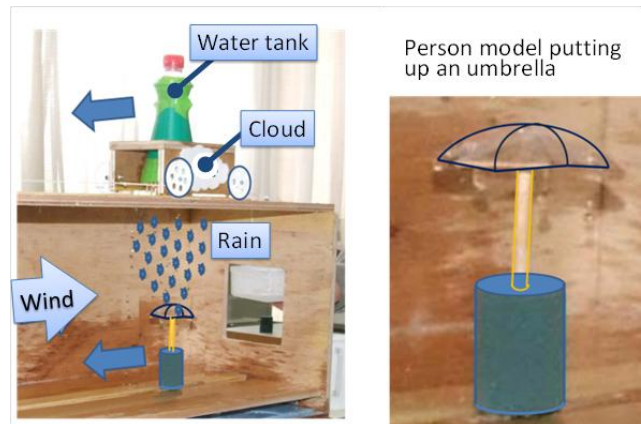


Figure 1. Experimental model.

### Consideration of Educational effect of FLCA courses

In Table 2, contents of the questionnaire which was used the survey for students' abilities and attitude after FLCA III course are shown. Each question in the questionnaire has two types of answers such as yes or no except for the question 5 having three types of answers. Furthermore, percentages of each answer to each question in Table 2 are given in Figure 2. As can be seen in Figure 2, 78% of students enjoy their experiment. In addition to this, 80% of students answered that they played their role in the process of team experiment. These facts suggest that students take part positively in the team experiment with their pleasure. This also means the change in their learning posture from passive to active. Moreover, it is obvious from the answers to the question 5 that 74% of students set up the working hypothesis based on some evidences. On the other hand, it is clear from the answers to question 3 that students are not good at investigation of literatures on their experiment theme. As a reason for this, it is considered that students in sophomore year still do not have the sufficient knowledge of technical terms on their theme and of scientific journals to be investigated.

As the educational effect in FLCA III course, the apparent change of students' attitude for learning from passive to active was observed. Namely, increasing the interest in their theme, the investigation of scientific journals on the theme changed into more concrete one and their thinking also changed into more logical and scientific one. Furthermore, they used instruments by their own efforts according to manuals for the usage of instruments and made their experimental apparatuses by themselves without any experience of handwork. Thus, it is clear that most students' attitude for learning changes desirably, if opportunity to think problems scientifically by themselves is provided.

As mentioned above, students can select freely the team experiment theme within familiar phenomena encountered in their daily life and must carry out their experiment by themselves in FLCA courses. This method for the selection of experiment theme is effective in the increase of students' motivation for carrying out of their experiment, because students are interested in their theme and know well the phenomenon selected by them. Besides this, carrying out of their experiment by themselves is also effective in the formation of their active attitude for learning and of their habits of scientific thinking. Because if they do not investigate literatures related their experiment and do not think about their experiment based on those, their experiment does not proceed to right direction. From these reasons, it is considered that students' attitude for learning changes gradually passive to active and their habits of scientific thinking is also formed gradually in the learning process of three FLCA courses.

Table 2  
Contents of the questionnaire for the experiment in FLCA III course.

No.	Question	Answer	
1	Could you enjoy the experiment?	A1	Yes
		A2	No
2	Could you played your role in the team, when the experiment is carried out?	A1	Yes
		A2	No
3	Are you good at investigation of literatures on the experiment theme?	A1	Yes
		A2	No
4	Was scientific information investigated useful for carrying out the experiment?	A1	Yes
		A2	No
5	What reason did you set up the working hypothesis based on?	A1	Based on the principle and the law related the theme
		A2	Based on observation
		A3	Without knowing why

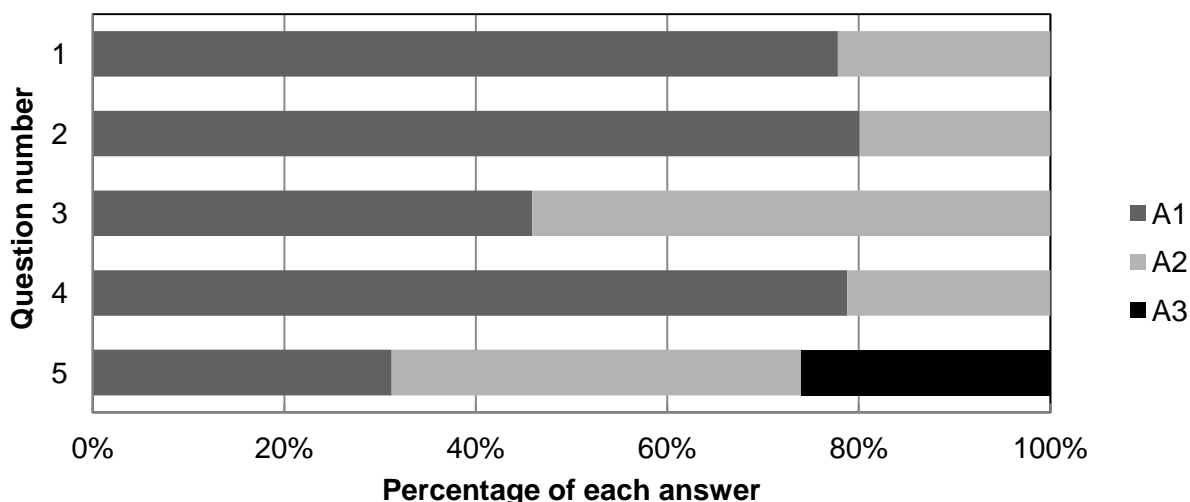


Figure 2. Percentages of answers from students to each question in the questionnaire

However, it should be took notice that these courses have educational effect only when students find their pleasure for thinking the theme scientifically with their continuous high motivation. In order to make students' attitude change like this, it is important that instructors enjoy the experiments and the scientific thinking on the themes with students. Because students are apt to lose their interest in their theme, when instructors are indifferent to their experiment and do not give any suggestions to them. On the contrary to this, when instructors think that their theme is very interesting and give proper suggestions to them, students carry out eagerly their experiment with interest and pleasure. Namely, it is necessary in this type of learning that instructors try to find out interesting point in their experiment, watch always progress of their experiment and give diligently adequate advices to students.

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