

Educational Effects of PBL “Co+work”

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Abstract

In order to evaluate the educational effects of an interdepartmental and mixed-grade course for the Project Based Learning “Co+work” Project, this paper describes the analysis results of questionnaire surveys based on student collaboration and socialization and competency tests through “Progress Reports on Generic Skills.” And, we discuss improvements of “Co+work” from the data and interviews of students and teachers. As a result, it can be seen that three competencies based on autonomy, cooperation and problem solving were significantly improved. The competencies of 4th year students improved more than that of the 3rd year students. Likewise, the 3rd year students’ competencies improved more than that of the 2nd year students.

In our college, students rarely have a chance to cooperate with other students enrolled in different departments. They are all enrolled in one of four technical majors which are mechanical engineering, electrical and information engineering, civil engineering, and architecture. Thus, our college started the new course, “Co+work,” as a compulsory credit to address the problem of that situation from 2016. The course includes three grades of students, 2nd, 3rd, and 4th year students, from each of the four departments. In total, 523 students were enrolled in this course last year and were divided into 63 groups to match up with 63 faculty members. As a result, each group contained 8 or 9 students, and one teacher per group took care of his or her group as a coach. This course aimed to cultivate competency in autonomy, cooperation, and creativity through the interaction of students from the different fields as they tackled the same project. The name “Co+work” is derived from the thought of having a need to create something by cooperating in practice. And, we believe it is important to have “co-” for communication, consensus, commitment, cooperation, and collaboration. Similar exercises have been implemented in many universities and Kosen (NIT colleges), but ours is unique in that the students consider and decide their topics to tackle rather than the teachers deciding and proposing what projects to do for them.

Keywords: competency, interdepartmental, mixed-grade, autonomy, cooperation, PROG, Co+work

Introduction

We are facing rapid social changes due to the recent circumstances in which globalization generates more people who have a wider range and more diverse sense of values and in which the progress of ICT makes it faster to acquire information. This urges people to refresh and renew their own abilities constantly along with these social changes. Thus, an ability to keep learning actively has become much more significant now than ever before. We are also facing complicated problems that involve multidisciplinary issues which require an ability to cooperate with professionals from other fields to tackle this complexity. Rieckmann (2012) also said universities may play very different roles in the future and may be more or less able to cope with global change and the complexity and uncertainty linked to these changes. And, the necessity of regular subjects for the purpose of nurturing generic skills in Japanese undergraduate education are advocated by Yoshihara (2007).

Unfortunately, in Japan, due to the declining birth rate and a growing tendency to have “play alone” single-child families, today’s youth have fewer opportunities to interact in groups. At the same time, passive education rather than active learning has remained mainstream in Japan. These situations make it difficult to cultivate competencies in collaboration, autonomy, and creativity.

Table 1 The schedule of 'Co+work'

Week	Overview
1 st	Guidance and team making in the gym
2 nd	Ice breakers and brainstorming activities with teammates in the gym
3 rd	Indonesian students joined us, NASA Game for making consensus in the gym
4 th – 7 th	Theme setting by each team
8 th – 14 th	Project progression by each team
14 th	Intermediate Presentations Four teams present their projects in one room. Seven minutes for presentations and 8 minutes for questions and comments.
15 th	Reflection by each team
16 th	Intermediate Guidance
17 th – 28 th	Project progression by each team
29 th	Final Presentations Poster session in the gym
30 th	Reflection by each team

Methods

The National Institute of Technology, Akashi College (NITAC) introduced Co+work to develop autonomy, collaboration, and problem-solving skills through experiments for creating goods or services that would make someone happy. And, we used review sheets, which were developed for the purpose of having students' record changes in their emotions as they went through each stage of their project (Saeki, et al., 2016). Table 1 shows the schedule of the Co+work course, which took place in 90-minute sessions on Thursday afternoons in the spring semester and Tuesday afternoons in the fall.

Table 2 shows the competency structure used for the Progress Reports on Generic Skills Test (PROG Test) in PROG Hakusho Project (2016). The PROG test was conducted on 26th January 2016 before Co+work was implemented and on 17th January 2017 after Co+work was completed. In accordance with PROG Hakusho Project (2016), the test consists of the following three types of computer adaptive questions:

- 1) *The bilateral selection format* which presents two ambiguous answer choices positioned side-by-side with hidden values and which forces the quick selection of one's first impression about the answer which they can relate to more closely.
- 2) *The scenario assumption format (short sentence)* which proposes answers that are generally considered to be positive for conflicting situations that anyone may be experiencing and asks how often the subjects have reacted in a certain way.
- 3) *The scenario assumption format (long sentence)* which proposes answers that are generally considered positive in response to conflicting situations that can occur in work places, and forces the selection of what actions to take in light of the subject's experience.

The examinees of the PROG test are all students of the 2nd year, 3rd year, and 4th year. Another way to survey, we divided all faculty members into groups of eight people and discussed about Co+work after the intermediate presentation and a questionnaire survey was conducted. Also, we conducted a questionnaire survey to student leaders of each teams in the meeting on 8th November 2016. The 63 Co+work projects for 2016 are listed in Table 3. These are the themes and summaries that the students chose at the beginning of the year, and they do not necessarily reflect the final product or service that the students presented in their final poster session. Some of these projects were difficult for everyone who gathered from different departments to participate in because the expertise required of some of the themes were biased toward certain specializations. At the same time, some projects were too easy to stretch out over two semesters.

Results and Discussion

The aforementioned information was gathered and reviewed for making comments on the following points:

- 1) The effectiveness of cultivating competency by PBL "Co+work"
- 2) Matters that should be improved for "Co + work."

Table 2 Competency Structure of PROG

	Main Categories	Subcategories	Specific Characteristics
Competency	Collaboration	Affinity	Friendliness
			Consideration of others
			Interpersonal interest, sympathy, acceptance
			Understanding, awareness, and tolerance of diversity
			Fostering of personal relationships
		Trust building	
		Cooperation	Understanding of roles and collaborative behavior
			Information sharing
			Mutual support
			Consultation, guidance and motivation of others
	Leadership	Dialogue engagement	
		Opinion sharing	
		Constructive and creative discussion	
		Adjustments of opinion, negotiation and persuasion	
	Autonomy	Emotional control	Self-awareness
			Stress tolerance
			Stress management
		Creating confidence	Understanding of identity
			Self-efficacy and optimism
			Self-transformation by being open to new learning viewpoints and opportunities
Sustaining action		Proactive behavior	
		Accomplishment	
	Making good behavior habitual		
Problem solving	Finding problems	Information collection	
		Understanding the essence of the problem	
		Cause pursuit	
	Planning a solution	Goal setting	
		Scenario creation	
		Plan evaluation	
		Risk analysis	
	Implementing the plan	Action taking	
Modification and adjustment			
Verification and improvement			

Table 3 Projects in “Co+work”

Team No.	Project Name	Project Summary
1	Making the Best Classroom	Tackle the problem of making a comfortable classroom.
2	Improvement of Sleep	Solve a problem regarding sleeping situations and improve daily life.
3	Amazing Skill!!	Make a paper airplane and its launching pad (Flying distance target 20m).
4	Making an Ideal School	Repeat the review, prototype, and improvement in order to make an ideal school.
5	Rube Goldberg Machine	Make the Rube Goldberg machine, and unveil it at a cafeteria and a nursing home.
6	Battle Against Drowsiness	Develop a sleep preventive device by which a patent is acquirable.
7	Stare at a Sweet Potato	Provide an easy, inexpensive, and good cultivation method for a sweet potato. From cultivation to consumption and marketing.
8	Let's Develop an Original Dressing	Develop the dressing with which even the person, who does not like vegetables, can eat a salad.
9	Bicycle Refrigerator	Remodel a part of a refrigerator so that the refrigerator can be driven by human-power, and make sherbet.
10	Project X(TEN)	Caricature a historical event and an inside story in a modern style, and produce fictional stories.
11	NIT, Akashi College Solenoid Project	Participate in a solenoid competition.
12	A Swing Blooms in a Wasteland	Maintain the space in front of the south bicycle parking area and build a swing to provide a recreation area.
13	Devisal of Useful Goods	Create a new thing and develop goods to untie the inconvenient things.
14	For Creative Meetings	Think about the better discussion method.
15	Monozukuri	Manufacturing by using wood and paper.
16	Let's Make Our Life More Convenient!	Think about a convenient goods for everyday life and aim at getting a prize in a contest.
17	Kosen Students' Obesity Project	Find out the best combination of snacks.
18	NIT, Akashi College Appeal	Summarize what we investigated about NITAC and upload it to our Web page.
19	Making Emergency Foods Recipe	Make an Emergency Foods recipe and provide it to the people in the community, and finally get their feedback.
20	Egg Drop Project	Learn about physics by dropping eggs without breaking them while challenging the Guinness Records too.
21	Pizza Taverna	Make a Pizza Baking Oven by ourselves and develop an original pizza.
22	Waste material Pitagora device - Dream of Children -	Make a Pitagora switch from waste material with the cooperation of the local community.
23	Transmit Kosen from the Viewpoint of Students	Transmit the Kosen's school life to Junior High school students from the perspective of students.
24	Operation Paper	Make a portable cardboard chair.
25	Let's Make Disaster Prevention Goods with Cardboard	Think about creation methods of disaster prevention goods using cardboard.
26	Let's Learn Japanese Culture	Plan the events that represent Japanese culture, and promote friendship with international students.
27	Aim at the Best in Japan	Do the best manufacturing in Japan that is useful for someone.
28	Love so Sweets	Develop an original sweet and aim at commercialization.
29	Reform a Wisteria-pergola	Reform a wisteria-pergola to a recreation area.
30	Make a Hard Mud Dumpling	Discover the potential of soil by making a mud dumpling.
31	Make Something New from Scratch	Produce ideas and make something new from scratch based on the ideas.
32	Out-there Smartphone Case	Design an epoch-making smartphone case that hasn't been around until now.
33	Intramural Bulletin Board System	Make an intramural bulletin board of the student, by the student, for the student, and upload it on the Web.
34	Quality Over Quantity	Apply for many competitions and acquire a necessary skill.
35	Improve Manners at School Project	Improve the issues of NIT, Akashi College and enlighten students and teachers.
36	OK Project (Aged Person Health Project)	Develop a new game to promote health and prevent dementia among elderly people, and introduce it to a nursing home.
37	Plant-culture by Using a Planter	Investigate the effective cultivation method of plants.
38	Making a Brochure of NIT Akashi College	Make a brochure for including overseas students.
39	Better Tasting Stockpile	Develop an innovative cooking method for stock food.
40	NITAC Lifestyle	Make a NITAC brochure and spread the information of NITAC to elementary and junior high school students.
41	~Stationalogy~	Develop new stationery.
42	Go Paper Airplane!	Make many kinds of paper airplanes and aim at Japan Records.
43	Enhancement of the Efficiency of Memories Formation Based on Brain Mechanisms	Survey human memory experimentally and understand the cognitive capacity of human beings objectively.
44	Bring about a Fresh Morning for all Mankind Project	Develop a new alarm.
45	Let's Make a Topiary in NITAC	Prune an overgrown tree and make a topiary.
46	Okashi Kosen	Make a snack particular to NITAC.
47	Think about Crime and Disaster Prevention Goods	Think about useful things for crime and disaster prevention.
48	Make a Future School Now	Aim at creating an environment which makes Kosen students live a better school life.
49	For You Plagued with Design	Develop stationery goods that Kosen students need in everyday life, and finally aim at commercialization.
50	Remodeling Plan of North Bench	Reform the benches on the north side of the sports ground and provide a recreation area.
51	Maintenance Operation of Vacant Ground in NITAC	Provide a recreation area in the back of the women's dorm.
52	Do Something Using Waste Material	Make a useful or enjoyable thing for the time of disaster.
53	Let's Develop the Capabilities of Elementary School Students Project	Make an environment where children engage with the local community and learn with pleasure.
54	Make People Smile Around the World-xxxxx iv	Investigate the issues that are going on in foreign countries while promoting exchanges with foreign people and find the solution.
55	I Will be a Triple Crown Winner	Participate in some competitions. At first, apply for DEZASEN.
56	Cool and Relaxing Place	Make a cool and relaxing place for NITAC students seeking comfort.
57	Pala Foods Story	Make an intellectual training toy targeting the age from 5 to 8.
58	Street Survey - About 10,000 Story Tellers -	Conduct a street survey and know about essence, action, thinking and feeling.
59	Simply Learn the Disaster Prevention Card Game	Make a disaster prevention card game for elementary school students.
60	Shutter Art Project	Revitalize a town by using shutter art.
61	Let's Make a Good Paper Airplane	Conduct the exchanges of views between each engineering specialty and reflect those views onto a paper airplane design.
62	KOSEN Healthy Vegetable Life	Grow seasonal vegetables and hold an event using the harvested vegetables at the Kosen festival.
63	Development of Disaster Prevention Goods Using a Sharing System	Develop convenient goods that are applicable as disaster prevention goods in the case of emergency.

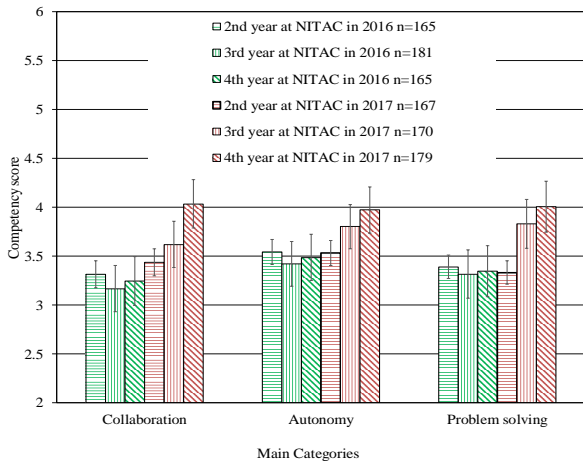


Figure 1 Competency before and after "Co+work" implementation (Averages shown with standard errors indicated.)

There were no obvious differences in competency scores between 2nd year, 3rd year, and 4th year students in 2016 before introducing Co+work as shown in Figure 1. This tendency, which is presumed to be a current problem of Kosen(NIT) education not being able to implement a curriculum for developing competency, was also reflected in the data presented by Okumura (2017) at the National Institute of Technology, Sendai College.

Figure 2 shows a comparison between the competencies of 4th year students at NITAC, 1st year science and technology students at a national university in Japan, and workers with overseas experience, or "global workers." Global workers are Japanese business people from age 25 to 49, who have management experience in Asia and have been satisfied with their management experience. This includes 735 people, who have worked in Asia for an average staying time of about 4 years.

Before implementing Co+work in 2016, the collaboration and problem-solving skills among 4th year students at NITAC were inferior in comparison to the 1st year university students. After implementing a second Co+work course in 2017, the competencies of 4th year students at NITAC obviously became higher than 1st year students at national public university in all main

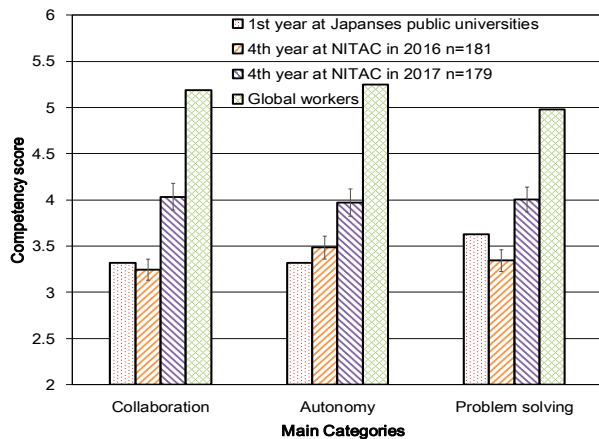


Figure 2 Competencies of similarly aged students and global workers (Averages shown with standard errors indicated)

categories. This clearly shows that Co+work is fostering competencies. Three competencies of 4th year students improved more than 3rd year students, who improved by the same measure compared to 2nd year students. One reason for this is considered to be that the more senior students became leaders in group work and the less senior students tended to have less responsibilities. However, by mixing different classes of students, those with seniority generally felt a sense of responsibility for taking on leadership roles. In addition, since it can be thought that the younger students can see their own growth model, this observation was necessary for the effect of the mixed grade-levels to be realized.

Figure 3 shows student improvements from 3rd year in 2016 to 4th year in 2017, and Figure 4 shows student improvements from 2nd year in 2016 to 3rd year in 2017 to demonstrate how the same students' competency details evolved from before to after Co+work implementation. The 16 specific characteristics have seen clear growth in collaboration, autonomy, and problem-solving. Only "making good behavior habitual" actually declined. This is thought to be due to the shortening of lesson time and the increasing of home study time in coincidence with the implementation of Co+work. The students are not adapting any further to the idea of making home learning habitual as a result of Co+work. Therefore, it is inferred that the growth of "making good behavior habitual" is not linked to Co+work because Co+work is as short as 90 minutes per week.

Looking at the changes from 2nd year to 3rd year in Figure 4, nine items are clearly improving. Only constructive and creative discussion see improvement under the main category of "Collaboration." This can be attributed to the fact that it is estimated that team leaders are mostly 4th year students, and 3rd year students are just "followers." As such, the 3rd year students' growth opportunities are missed in this situation. However, obvious growth is seen in five specific characteristics under "problem-solving" for 3rd year students. It is considered that there is significant improvement in the ability of problem-solving because this is an interdepartmental project, and it is necessary for the students to choose their themes together. Making good behavior habitual also appears to decline among 3rd year students. Unfortunately, according to surveys from teachers and students, the project themes were not always easy for everyone to embrace. For example, in Team No. 9, the theme "Bicycle refrigerator," shown in Table 3, was decided by a student of mechanical engineering who was eager to implement his plan. Everyone was interested at the initial stage, but as the work progressed, the motivation of the students from the Departments of Architecture and Civil Engineering could not be maintained. Therefore as each project progressed, the degree of participation increased for the students who had an expertise related to the theme, and the degree of participation decreased for those who did not have such expertise. Therefore, it is necessary to find a theme that each student can participate in, such that an interdisciplinary theme combining different specialized fields is made and each student to has a clear

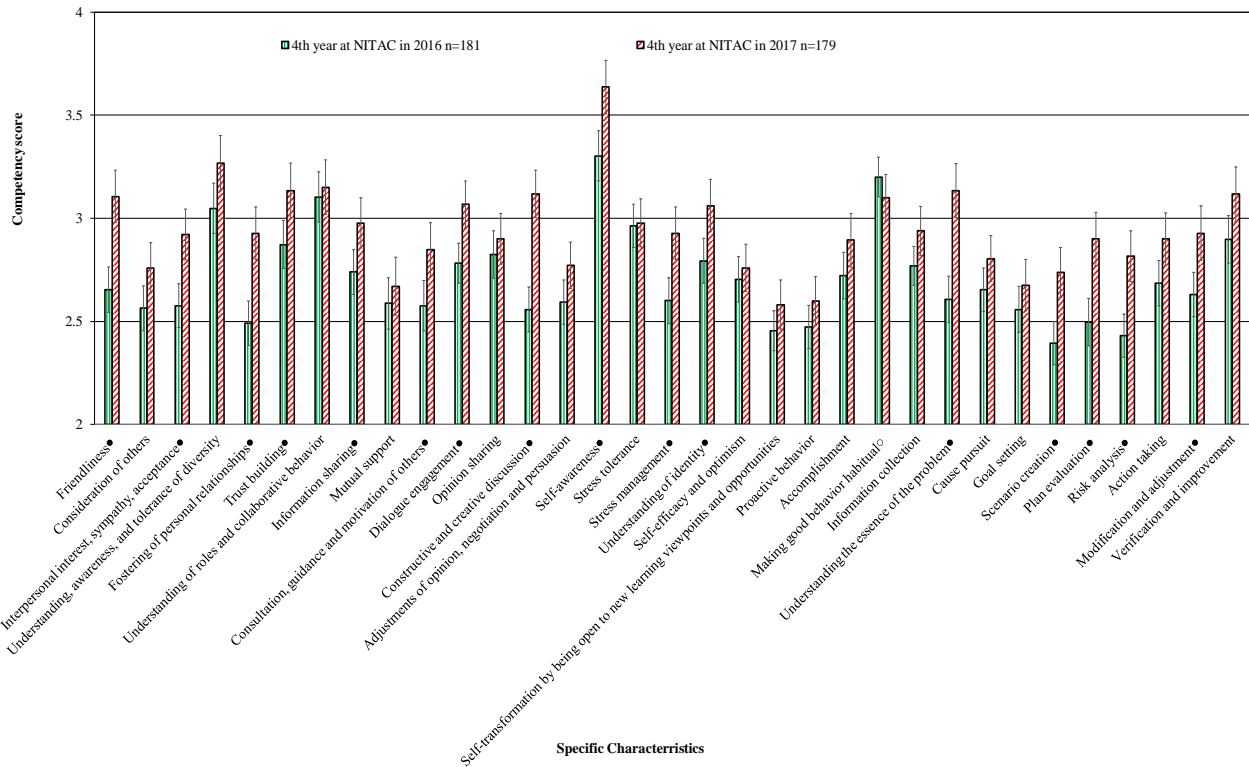


Figure 3 Specific competencies of students from 3rd year in 2016 to 4th year in 2017

(Averages shown with standard errors indicated. Specific characteristics marked with “●” showed clear improvements, and those marked with “○” showed declines.)

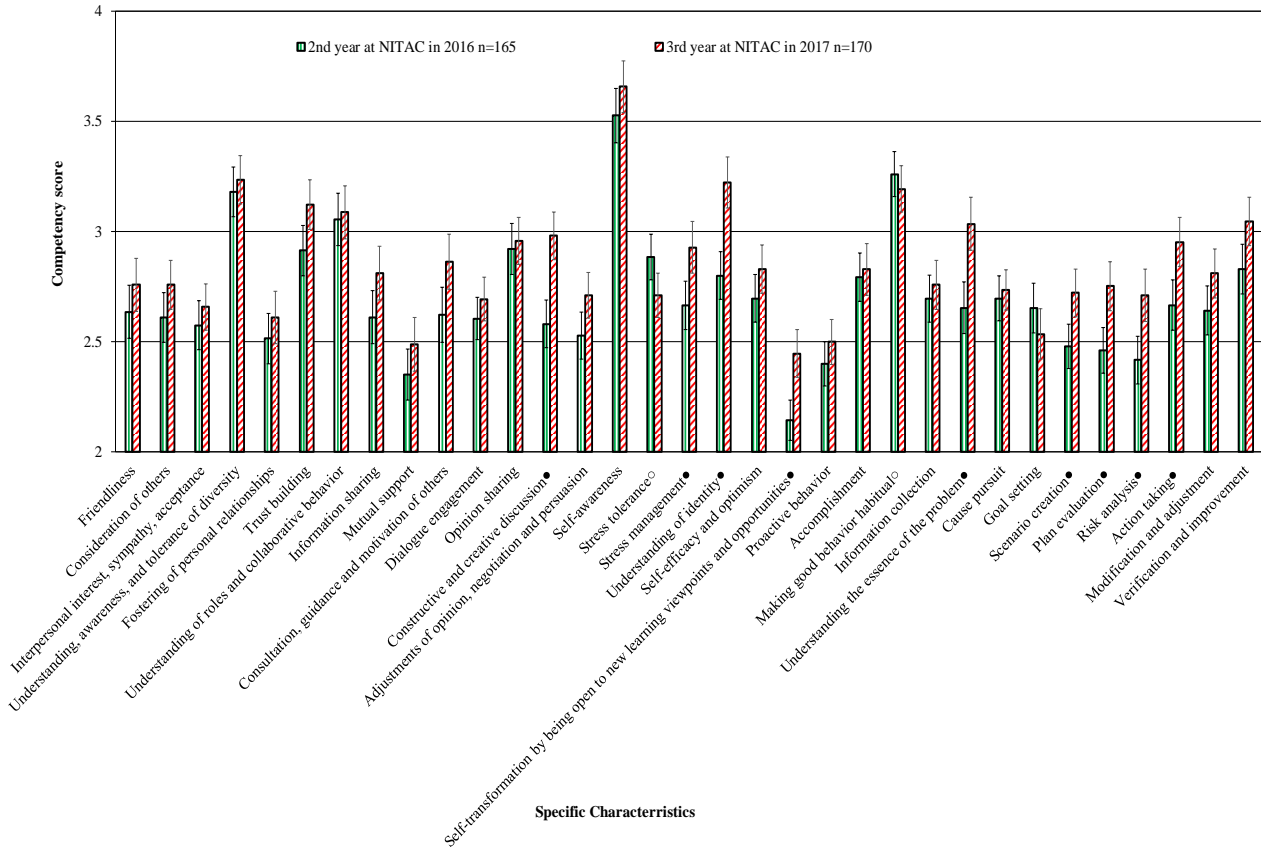


Figure 4 Specific competencies of students from 2nd year in 2016 to 3rd year in 2017

(Averages shown with standard errors indicated. Specific characteristics marked with “●” showed clear improvements, and those marked with “○” showed declines.)

role in group activities.

Interview responses suggest that ice breaking activities and team building in the initial stages were highly approved by many students. The group activities thereafter become smoother by building good human relationships from the beginning. For Kosen students who lack communication with people of different ages and expertise, it is difficult to collaborate suddenly with strangers. Particularly to encourage proactive communication between 2nd and 3rd year students, it is important to build relationships like this.

Figure 5 shows the responses to the question “How was the project theme determined?” from teachers. Teachers did not determine the theme of the projects because students’ interests depended on their majors, and it was both difficult and undesirable to impose the teachers’ expertise.

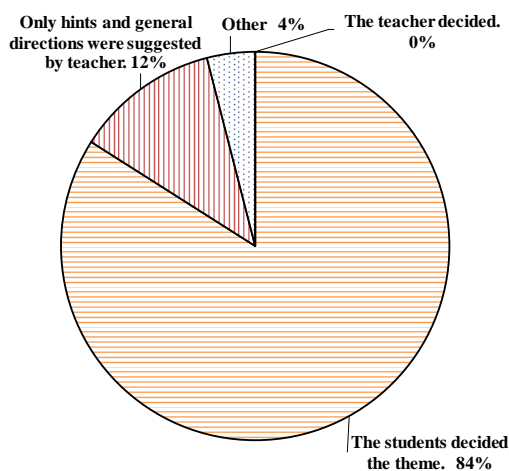


Figure 5 Responses to “How was the project theme determined?” from teachers. n=51 The response rate from teachers was 81%.

Figure 6 shows the responses to the question “Were you able to determine the theme smoothly?” from the student team leaders. The responses “I disagree.” and “I somewhat disagree.” accounted for 53% of the responses.

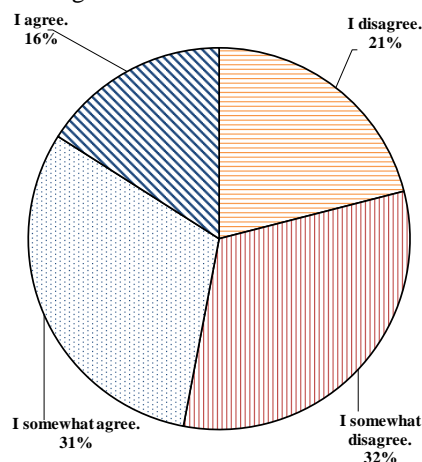


Figure 6 Responses to “Were you able to determine the theme smoothly?” from the student team leaders. n=62 The response rate from student leaders was 98.4%.

Conclusions and implications

From the PROG test, questionnaires to teachers and students, and hearings, the following can be concluded:

- 1) In the past, in Kosen education there was no obvious competency growth.
- 2) Competencies of 3rd year and 4th year students obviously grew by the implementation of Co+work.
- 3) Competencies in problem-solving improved through Co+work because students set their own themes.
- 4) It is important to make good relationships through team building in the initial stage.
- 5) The setting of themes that everyone can participate in is important for maintaining motivation to complete activities.

As Co+work is a 3-year program, which has only reached its half-life, it is necessary to conduct a continuous investigation from here on. And, in order to facilitate a more thorough investigation, from the 2017 spring semester we have introduced a rubric evaluation to clarify the purpose of Co+work.

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