Career Education for First Year Students of Science and Technology to Improve Awareness of Working in Society

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Abstract

The Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) proposed the concept of "Bachelor's abilities" and started a support program known as "university students' employability" in 2010. In this article, we introduce the contents of this program. In addition, we mention the relationship between this program and the conventional concept of "employability skill". We also introduce two courses, "career planning" and "career design", related to this support program for first-year students in the field of science and technology. The aim of these courses is to improve students' awareness for working in society. A questionnaire survey was conducted in order to understand first-year students' characteristics. The survey was carried out with more than 2600 students over a period of five years. Survey results revealed that many students had no image of their future at the time of admission to the University. It seems that the obtained data shows the degree of consciousness of the average Japanese student in their first year at university. Through the introduced courses, students were able to consider their own future and discover their own goals and the significance of studying at University.

Key words: Career education, employability skill, bachelor's abilities, student's awareness, questionnaire survey

Introduction

For students of higher education, skills related to employability are as important as those related to technology of their specialized fields. Skills of employability are not a simply defined competence such as communication skills, teamwork skills, technical skills and so on, but are rather a comprehensive or integrated competence inclusive of all of these skills. These skills are also closely related to generic skill theory (ANTA, 2003). Moreover, the contents of employability skills might be derived by the needs of employers in the manufacturing industries.

Studies on employability related to engineering education have been carried out by numerous researchers from various perspectives. For instance, Rasul et al. (2009) investigated important aspects of employability skills required by employers in the Malaysian manufacturing industry. They found that interpersonal and thinking skills were most valued. Further, while basic skills, resource skills, system and technology skills and personal quality skills were considered important, informational skills were only adjudged moderately necessary. In another study, Othman et al. (2010) investigated whether the PBL of applied mathematics was effective for enhancing employability skills among graduates, concluding in the affirmative. Rhmat et al. (2012) investigated the relationships between employability and graduates' perceptions of their own skills for students of Information Science and Technology. Through the investigation, they concluded that the skills learned in the faculty were in line with industry requirements.

Ismail and Mohammed (2015) have reported examples of introducing employability skills in Federal Universities of Technology in Nigeria. In this report, the relationship between employability skills and generic skills was mentioned. Misra and Khurana (2017) have reviewed the definitions proposed and mentions of employability by past researchers as a literature review. Additionally, they discussed the required skill set for enhancing the employability of graduates and employees focusing on the information technology field, and proposed a checklist of employability consisting of six major skills.

As described above, studies about employability skills are certainly not lacking in number. However, in contrast with the conventional concept of "employability skills", the approach reported herein of the "employability program" of Japan revolves around a unique way of thinking and has a different definition. In the next section, we will provide an outline of Japan's higher education along with relevant historical changes, and will describe the introduction of the "employability program" of Japan. Furthermore, in the following section, we will also introduce our initiatives in response to this program.

The first purpose of this paper is to introduce a new effort towards employability education in Japan. We also describe the courses related to this education that have been implemented at our university. Secondly, we investigate the consciousness of first-year students who entered the Faculty of Science and Engineering in order to know the characteristics of students. As a result, the consciousness of students at the time of entrance to university becomes clear.

Historical Change of the Higher Education System and Its Reforming of Japan

After the close of World War II, Japan achieved great economic growth. Japan's economic situation shifted to a stable period from 1970 to 1990 as shown in Fig.1. Internationalization also advanced during this period. The Japanese population in this period gradually increased, and the 18-year-old population enrolled in universities also increased. In the economic-growth period, university education was "elite education" for a small number of students, and subject mainly focused on specialized subjects.

In 1992, Japan experienced collapse of the bubble economy and the economic situation changed to a period of low economic growth. Simultaneously, our country shifted to an aging and low birthrate society. In this post-bubble economic period, the 18-year-old population enrolled in universities decreased and the popularization of higher education (i.e. mass education) started. Currently, the percentage of high school students continuing to a higher level of education became over 70% (MEXT Japan, 2013). Universities now have the function of an educational institution that accepts not only high school graduates but also working persons and diverse human resources in various positions. The scenario of this shift from "elite education" to "universal education" through "mass education" is famously known as "Martin Trow's theory" (Trow, 1973; Amano, 2010). Along with such qualitative changes in university functions, there were great changes to the educational contents of university.

In these university situations, new educational efforts are required as shown in Fig.1. For example, enhancement of English education corresponding to globalization (Yamada, 2017; MEXT Japan, 2014) and introduction of career education were required (Hanada et al., 2011; Morita et al., 1018; MEXT Japan, 2010). Generic skill education was also introduced at many universities in addition to the specialized education (ANTA, 2003; Le & Tam, 2008; Rahman et al., 2011; Rodzalan & Saat, 2012; Ogawa & Shimizu, 2016; Yong & Ashman, 2019). Generic skills are fundamental and common skills that can be applied to business and professional occupations, rather than skills relating to professional knowledge in specific fields. In the science and engineering fields, the acquisition of not only specialized knowledge but also generic skills are required.

Several assessment and assurance systems to maintain educational quality were introduced to university education such as the VALUE Rubric (Reddya & Andradeb, 2010) and OECD-AHELO (OECD, 2008). JABEE (Japan Accreditation Board for Engineering Education) is an assurance system for the engineering fields and has been introduced in many engineering faculties of universities (JABEE, 2019).

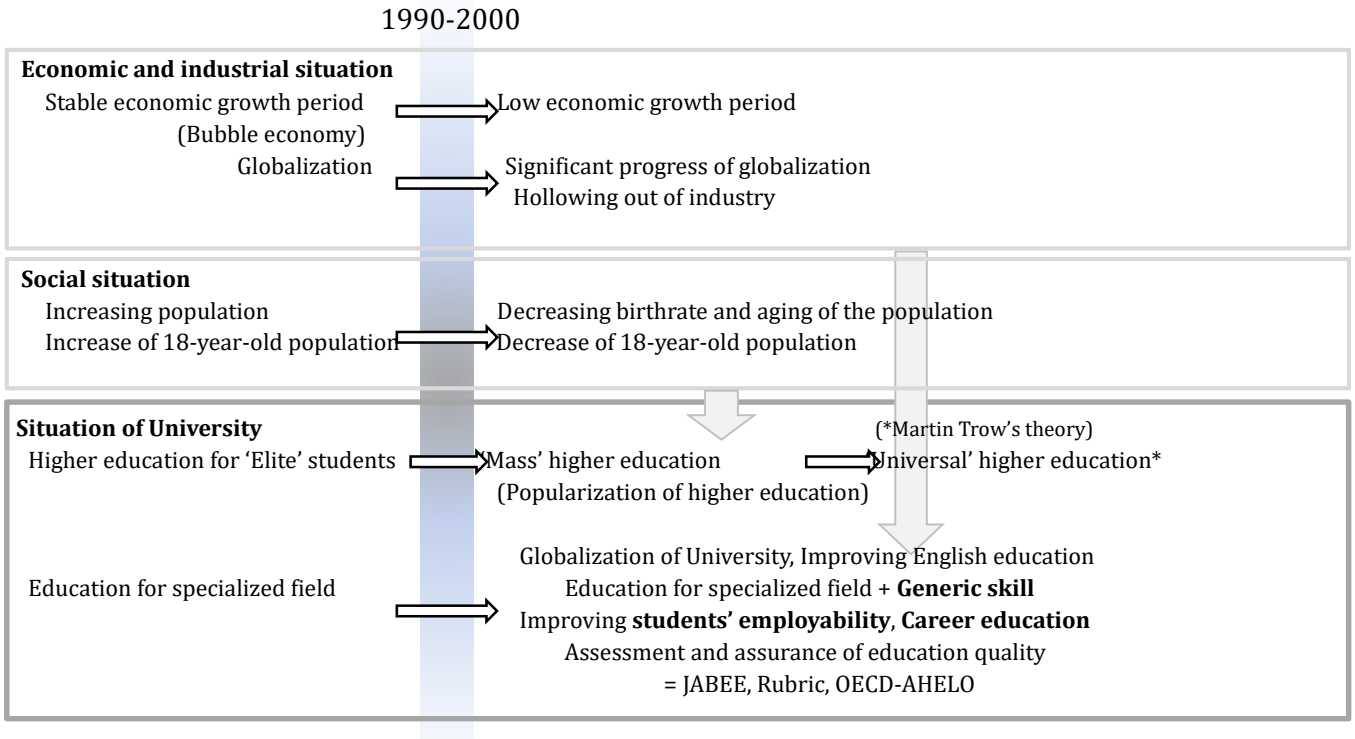

Fig.1 Historical change of Japanese economic, social, and educational situations

Fig.2 shows the historical development of the generic skill concept and change of the Japanese education system. The concept of generic skills was initially established by the Karmel Committee of Australia in 1985 (ANTA, 2003). This work was then taken over by the Mayer Committee, which developed key competencies for student employment. Barnett (1994) discussed the classification of four types of competences for university students' education in his paper. The concept of competences was introduced as one of the elements of generic skills. Many countries introduced the generic skill concept for enhancement of their education systems. In 2003, the Australian National Training Authority (ANTA) summarized the common elements (competences) of generic skills from various education studies related to generic skills (ANTA, 2003).

The University Council of Japan published a vision for university education of the 21st century in 1998 for educational reform (MEXT Japan, 2013). In 1999, JABEE was established as a non-governmental organization (NGO) and a member of the Washington Accord. The target of JABEE is the university's educational programs in engineering fields. Accreditation criteria are introduced to check whether students are able to receive international attributes through the curricula from their education program (JABEE, 2019). JABEE set the specialized knowledge of science and technology, engineering design ability, communication skills, ability to work in a team, professional ethics and so on as the attributes. These are very close to the competencies of generic skills.

The Central Council for Education in the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan also proposed the concept of "Bachelor's abilities" (MEXT Japan, 2010; MEXT Japan, 2012). In this concept, similar elements related to the generic skill competences were introduced. The relationships between "generic skills", "bachelor's abilities" and "JABEE's accreditation criteria" are described in Fig.3.

Moreover, MEXT started the support program for "students' employability" for university education in 2010 (MEXT Japan, 2010; Matsumoto et al., 2012). This program was to support universities which promote students' social and professional independences as described in what follows (some sentences have been partially omitted):

1) Students cultivate their own view of occupation and work through first-year education, and have a basic perspective on their own way of life and lifestyle (including work-life balance).
2) In addition to (1), students are able to choose their future career paths at their own responsibility while understanding their individuality and abilities. Additionally, they are able to independently assemble their university life, select appropriate subjects and courses, and systematically pursue their studies.
3) Based on (1) and (2), students learn about how the specialized knowledge and skills gained through classroom lectures will be used in the real fields of companies at the forefront, and learn continuously and deeply with a purposeful consciousness. As a result, they acquire the socially necessary and practical skills useful after graduating university.
4) Through this course, students will be able to confirm a variety of knowledge. Skills gained through university life are systematically integrated within the course and the minimum qualities and ability required for professionals as a university graduate are formed.

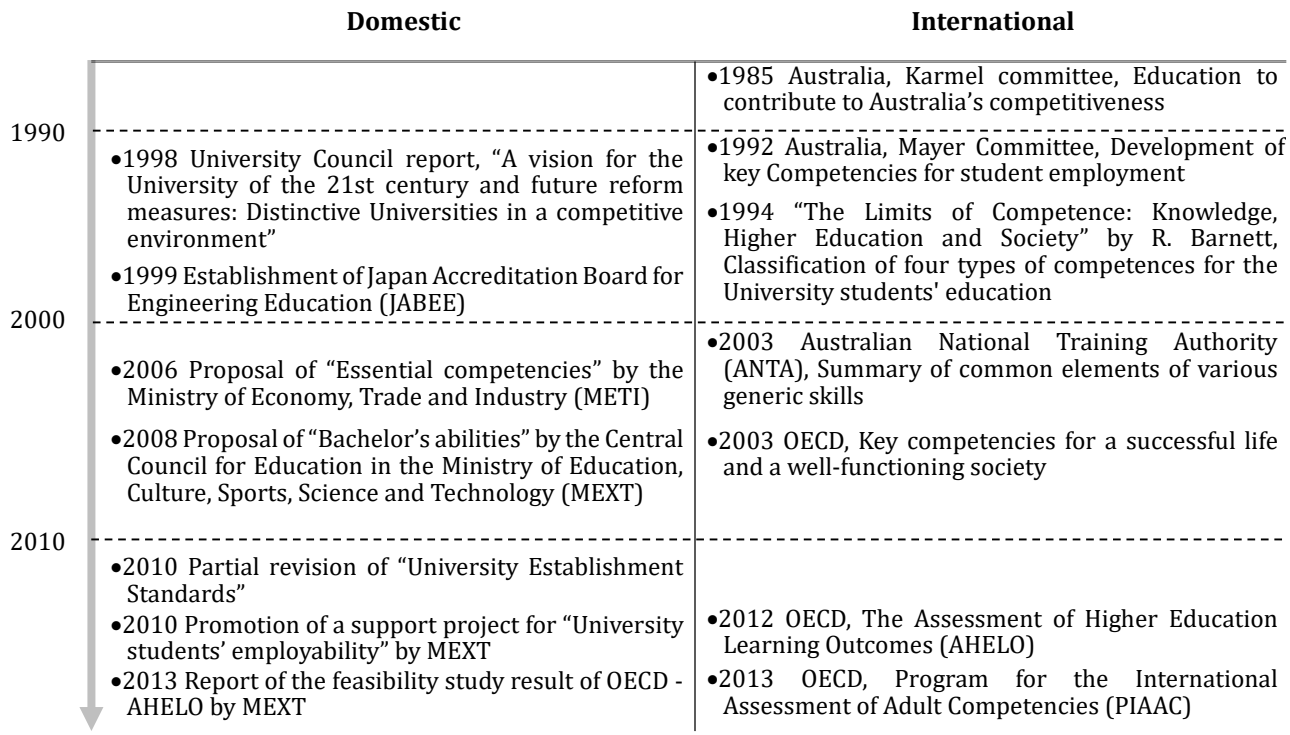

Fig.2 History of the development of the generic skills concept and the Japanese education system

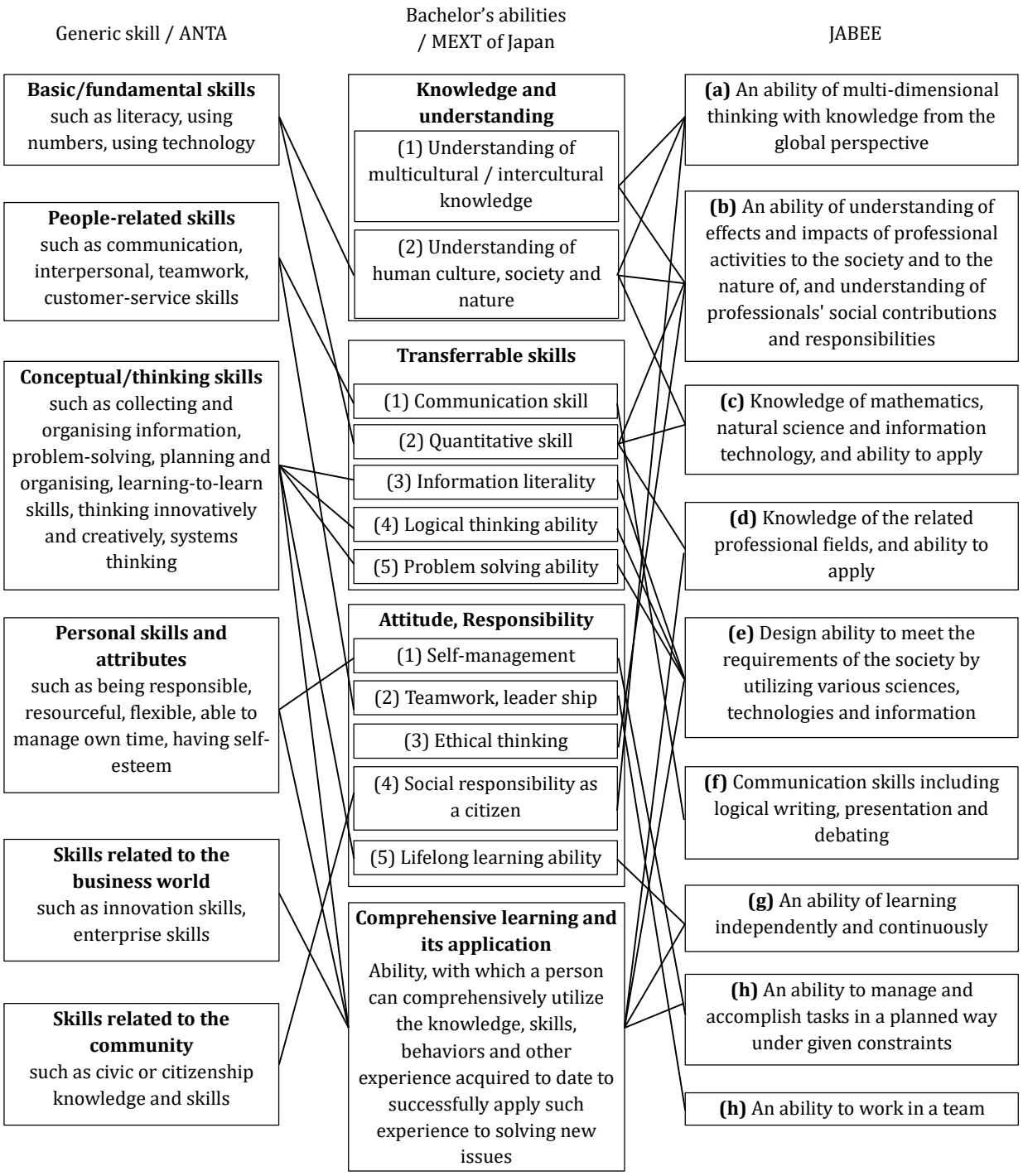

Fig.3 Relationship among "generic skill", "bachelor's abilities" and JABEE's criteria

These definitions also closely relate to the generic skills concept, especially the requirement that university students develop self-management ability of career design for their future life through the university curricula. This ability is the foundation for development of personal skills attributed in generic skills.

Career Education Curriculum in Gunma University

The Faculty of Science and Technology of Gunma University started a new program related to "students' employability" in 2010 (Matsumoto, 2012). Subjects of "career planning" and "career design" were newly introduced as part of the first-year studies in the program. PBL type English i.e. "English C" was also introduced for second-year students and "Scientific English" moved from 2nd to 3rd year. Moreover, a new subject, "Internship I", was introduced in the second year as pre-training for "Internship II". These improvements are summarized in Table 1.

The contents of "career planning" and "career design" are summarized in Table 2. "Career planning" is a required subject in the first semester of 1st year. In total, about 500 freshmen take this course, divided into two classes of around 250 students.

Many students feel uneasy because they have just entered university and have no friends at this time Therefore, this class also plays an important role in promoting smooth communication between students. The main goal of this class is offering support for students themselves to develop a meaningful university life. “Career design” is an elective course in the second semester of the 1st year. Students are able to freely select this subject, with approximately 200 usually enrolling.

Table 1 Improving the program of “students’ employability” in Gunma University

Before establishment of the improving program of “students’ employability”

1st grade	2nd grade	3rd grade	4th grade
English*A,B [required]	Scientific English I, II** [required]	Internship** [elective]	Graduation Research** [required] (PBL education)

After establishment of the improving program of “students’ employability”

Career plan* [required] Career design* [elective] English A,B* [required]	Internship I** [elective] English C* [required] (PBL type)	Career Development** [elective] Internship II** [elective] Scientific English I, II** [required]	Graduation Research** [required] (PBL education)

* Liberal arts ** Specialized Subjects

Table 2 Contents of “Career planning” and “Career design” classes (2016-2019)

Career Planning (First semester / Required subject)	
Weeks	Contents
1	Introduction to the improving program of “students’ employability”
2	Explanation of “curriculum map” and first questionnaires
3	Review of “curriculum map ” and group discussion of future plans
4	Continuation of group discussion of future plans and second questionnaires
5-9	Food education for health and diet, Social security and pensions, Tax education, Career-anchor test
10-15	Field work (visiting companies and/or university laboratories, training camp)
16	Summary of the class and final questionnaires
Career Design (Second semester / Elective subject)	
Weeks	Contents
1	Introduction of “ Career Design ” with group work
2	Introduction of “ Career Design ” with group work (continued)
3	Lecture by a recent graduate
4	Group work (group discussion related to the lecture)
5	Lecture by a key alumni
6	Group work (group discussion related to the lecture)
7	Lecture by an university president
8	Group work (group discussion related to the lecture)
9-11	Lectures by instructors for group presentations (Making of a poster)
12-15	Poster presentations by groups on career design
16	Summary of “Career Design” class and final questionnaires

Questionnaire Investigations to Grasp Student Characteristics

Many students do not have a clear future goal at the time of admission to university. Before starting the study of liberal arts subjects in the first year and more specialized subjects in that following, it is important to accurately grasp the characteristics and consciousness of students immediately after admission. For this purpose, various questionnaires were conducted at the start of the class.

In order to collect as much as possible, the candid opinions and consciousness of students immediately after enrollment, we prepared simple questions. The questionnaire was conducted in the "career planning", as it is a required course for all first-year students. Our faculty has five departments: "Chemistry and chemical biology", "Mechanical science and technology", "Environmental engineering science", "Electronics and informatics" and "Integrated science and technology". The total prescribed number of students at admission is 510. Data was collected over five years from 2015 to 2019. In order to increase the response rate, we developed a questionnaire input system using a mobile phone. For the questionnaire, students used their mobile phones to access the questionnaire's items. The number of respondents is summarized in Table 3. The total number of respondents was over 2600 over five years. Since all first-year students participated in this class because it is a required subject, it was possible to obtain data from the students with a high response rate as shown in Table 3.

Although respondents were asked about many items, the current paper shows the results of the following two questions: The first question was "Was this university your first choice?" Students could select from the following four answers: "Yes", "First choice was another University", "First choice was another faculty" and "First choice was another department". The second question was "Are you a scientific type person?" Students could select from the following choices: "Yes", "No", "No idea" and "I don't understand the meaning of scientific type person".

The results are shown in Fig.4. These results indicate that about 50% of students chose our university as their first choice. However, about 44% of students had hoped to enter another university. That is, many students may have entered unwillingly. About 17% of students thought that they are not science-oriented persons. Furthermore, about 40% of students answered "No idea". This means they do not know whether their own personalities are a scientific type or not. This result shows that many students may have entered this program whether their personalities fit the university's characteristics or not. These results strongly suggest the need for motivation enhancement and awareness in the first year after university entrance.

Table 3 Data of respondents about the questionnaires

	Number of respondents (first question)						
	CB	MS	ES	EI	IS	Total	Response rate
2015	164	123	96	128	31	542	99.3%
2016	160	117	95	130	30	532	98.2%
2017	158	118	93	125	32	526	96.7%
2018	166	114	90	125	32	527	100.0%
2019	173	125	90	123	33	544	100.0%
Total	821	597	464	631	158	2671	98.8%
	Number of respondents (second question)						
	CB	MS	ES	EI	IS	Total	Response rate
2015	164	123	96	130	30	541	99.1%
2016	159	116	95	129	30	529	97.6%
2017	157	118	92	124	32	523	96.1%
2018	166	114	90	125	32	527	100.0%
2019	173	125	90	123	33	544	100.0%
Total	819	596	463	631	157	2664	98.6%
CB	Department of chemistry and chemical biology (160) *						
MS	Department of mechanical science and technology (110) *						
ES	Department of environmental engineering science (90) *						
EI	Department of electronics and informatics (120) *						
IS	Department of integrated science and technology (30) *						
	* Prescribed number of students at admission (total = 510)						

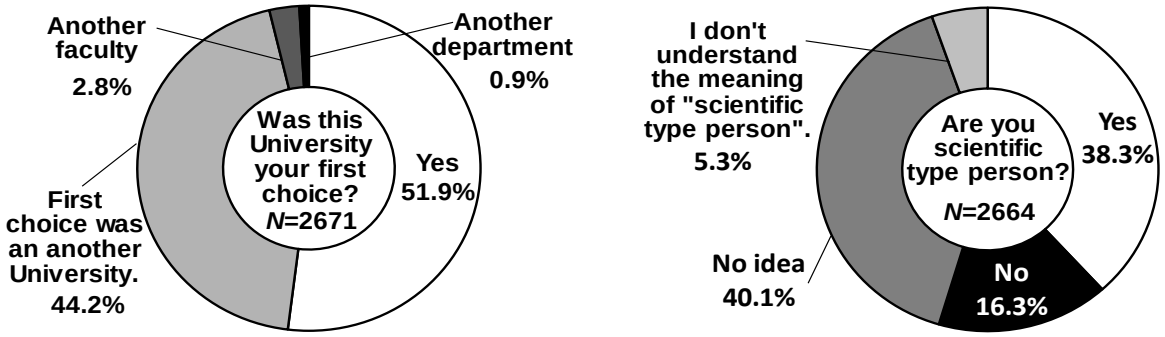

Fig.4 Questioner results for freshmen of student in faculty of science and technology

Trial for Enhancement of Students' Motivation and Awareness

In order to understand curriculum structure over the four years of university study, subjects to be learnt in the following years were explained using a "curriculum map" in the first stage of the class. Via such explanation, students might understand what kinds of knowledge can be learned over their time at university. They can obtain more of an image of the specialized fields they will learn in the future. It is very important to imagine future study for the establishment of students' own purpose at the university age (see Fig.5).

Many questionnaire investigations were carried out in the class to understand the students' thoughts. The mobile phones of students were used as input devices. Results of the answers were fed back simultaneously as aggregated data projected on the screen in the classroom as shown in Fig.5. Fig.6 shows a photograph of the students watching intently as the

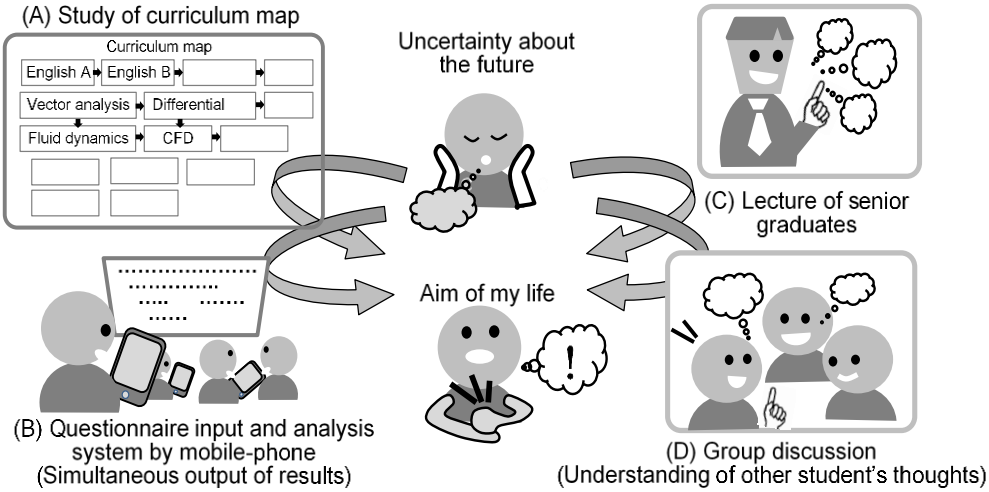

Fig. 5 Student's enhancement trial in improving the program for students' employability

Fig.6 Display of questionnaire results

Fig.7 Group discussion by students

results are projected on the screen. Through this system, each student's individual opinions were anonymously projected onto the screen. Students could know what kind of future images and vision other students have. Moreover, students might be able to compare their own vision with those of others. These processes will be effective for students' own building of career plans. In addition, this ICT-based interactive questionnaire system is effective for not only discussing the results but also for supporting active learning.

In the class of "career design", senior graduates were also invited to share stories of career-building and experiences during and after graduation. The first-year students listened seriously especially about these senior peers' experiences of failure and what they ought to do in their student days. Based on other students' thoughts and the contents learned through the lectures of senior graduates, groups discussed how each student should develop a plan for their university life and the future. Students discussed through group-work what they considered they should learn in their school days based on the contents of lectures by graduates. In order to summarize the results of the discussion, they also trained using the KJ method, a famous business tool for the organization of ideas (Kunifuji, 2013). It seems that these trials have been effective in assisting students to make clear future images of them. Figure 7 shows a photograph of group discussion in which students are enjoying communications with each other. Through these efforts, we expected that students would acquire various abilities related to generic skills, such as communication, teamwork, and flexible-thinking abilities, whilst also developing their self-esteem. In the classes of "career planning" and "career design", many distinctive and unique attempts have been carried out as shown in Table 2 in addition to those activities described above. For example, food education for health and diet, social security and pensions and tax education were also carried out by invited experts. Career-anchor tests were conducted in order to understand the characteristics of students themselves (Harada, 2006). Details and effects of these trials for the freshmen students will be reported in future works.

Before the start of second semester, a questionnaire on "career planning" class was conducted for the students who took a class of "career design". One of questions was "Through the first semester, did you come to think about your future?" Data were obtained from 2011 to 2015. The total number of students was 988. The number of respondents is summarized in Table 4. Data was collected using a mobile phone as mentioned above. The response rate was 100% for every year. Students could select "Yes" or "No". Figure 8 shows the obtained result. More than 80% of students selected "Yes". The same investigation was carried out in 2019 with a slightly revised question: "Did the career planning class give you an opportunity to think about your future?" The number of respondents was 196. Figure 9 shows the result. There were no students who answered "No". More than 70% of students answered "Yes". These results suggest that the class of "career planning" gave a good opportunity for students to think about their future.

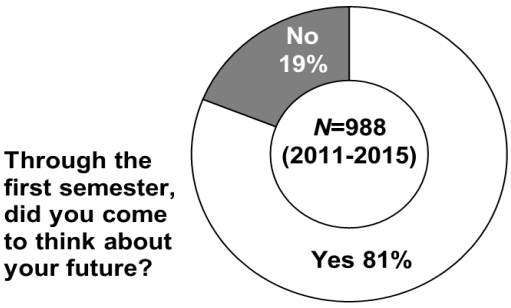

Fig.8 Questionnaire result about the effect of "career planning" (2011-2015)

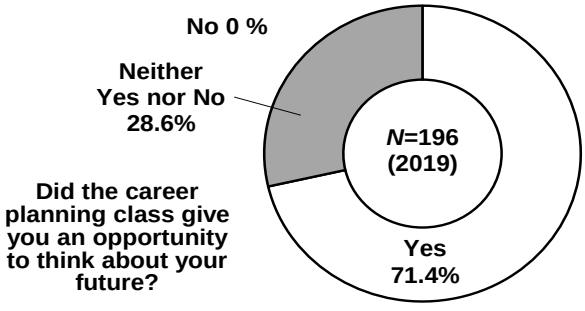

Fig.9 Questionnaire result about the effect of "career planning" (2019)

Table 4 Data of respondents about the questionnaires in "career design"

	Number of respondents	Response rate
2011	197	100%
2012	213	100%
2013	200	100%
2014	156	100%
2015	222	100%
Total	988	100%

Conclusions

In this article, details about the "improving program for students' employability" during university education in Japan were introduced and the relationship to generic skills was discussed. The concept of "Bachelor's abilities" introduced to the education system of Japan by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) was also discussed in relation to generic skills. We then reported on a new education program of "students' employability" which was started in Gunma University in 2010. The contents of "career planning" and "career design" classes introduced to the first year of the program were also reported. A questionnaire survey conducted as part of this program over five years for more than 2600 students showed that many students had no image of their future at the time of admission. The results suggest that for the enhancement of motivation it is important for students to be presented with opportunities to consider their own future images. It was confirmed that students had such opportunities to think about their future work images through various efforts such as group work, lectures by alumni and listening to the other students' thoughts in the classes of "career planning" and "career design".

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