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Survey and Analysis of Computing Education at Japanese Universities: Subject of "Information" for High School Teacher's License*

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Abstract. We conducted the first national survey of computing education at Japanese universities in 2016. In this paper, we report the survey result of the computing education to obtain high school teacher's license on IT. The survey covers various aspects of computing education including program organization, quality and quantity of educational achievement, students, teaching staff and computing environment. We collected 338 answers through the survey which cover 65% of the departments having teacher's license course on IT. Many of the responded departments also provide computing education majored in computing discipline. Although 5,006 students are enrolled in the computing education for the license, only 369 students obtain the license since very few are employed at a high school. Most of the teacher's license holders on computing subject also obtain high school teacher's license of other subject in order to get a job as a high school teacher.

Keywords: computing education, subject of information, high school, teacher's license.

1. Introduction

Computing education is essential at modern universities. There are four types of computing education in Japanese universities:

A. Computing education at a department or a course majored in computing discipline.
B. Computing education at a non-IT department or a course as a part of their major field of study.

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C. General computing education for all students at a university or a faculty typically at the first or second academic year.
D. Computing education to obtain high school teacher's license on computing subjects.

The Science Council of Japan announced the reference standard of informatics (Hagiya, 2015) for university education in March 2016. The reference standard provides a common body of knowledge (BOK) for college level computing education and the Japanese government accepted this as the definition of computing education.

This survey is designed to analyze and understand current status of computing education at Japanese universities from various aspects including program organization, quality and quantity of educational achievement, students, teaching staff and computing environment.

In this paper, we report and discuss the result of the survey type D for computing education to obtain high school teacher's license on computing subject. The Enforcement Regulations of the Japanese Education Official License Law defines requirements for an education program to issue a regular high school teacher's license for the subject "Information" in chapter one, named Method of Learning Units, article 5. It is necessary for a program to include the following six subjects:

1. Information society and information ethics.
2. Computer and information processing including practical training.
3. Information system including practical training.
4. Information communication network including practical training.
5. Multimedia expression and technology including practical training.
6. Information and occupation.

A program needs to be accredited by the Japanese government to fulfill the requirements. The Japanese ministry of education (MEXT) maintains the list of the accredited programs.

We have already published the survey outline in (Kakeshita, 2017b) . The results of other survey types are also published as separate papers (Kakeshita, 2018; Kakeshita and Kakeshita, 2017; Kakeshita, 2017a; Ohtsuki *et al.*, 2017). Information processing society of Japan (IPSJ) will utilize the survey result to develop the new J17 curriculum standard (IPSJ, 2018). MEXT will utilize the survey result to improve the national policy of computing education.

2. Survey Outline

2.1. *Survey Questions*

The following is the list of questions for survey type D. As the reader can understand from the list, our survey covers various aspects of computing education by considering the Japanese standard for establishment of universities and our experience of accrediting computing programs in Japan.

- Name of university, faculty, department and course.
- Program organization:
  - Day time, night or remote program.
  - Academic discipline of the program such as engineering, social science and humanities.
  - Required number of credits of computing subjects for graduation.
  - Number of computing subjects provided.
  - Classification of the computing subjects.
- Quality and quantity of educational achievement:
  - See Section 2.2 for detail.
- Student:
  - Regular academic years of computing education.
  - Quota, Number of enrolled students.
  - Number of students who obtain the license.
  - Student's choice of career after graduation.
- Teaching staff:
  - Number, educational background, current specialized field, tenure of faculty members.
  - Number and workload of support staff and teaching assistant students.
- Computing environment:
  - Educational computer system.
  - Student's own PC and utilization at class.
  - Educational programming language.
- Other topics:
  - Future plan and strength of the program.
  - Utilization of IT certification and/or qualification.
  - Special remarks.

2.2. *Survey of Quality and Quantity of Educational Achievements*

The survey of quality and quantity of educational achievements is the core of our survey. We define six achievement levels for knowledge and skill represented in Table 1. These levels are used to describe educational achievement.

We also define a BOK based on the reference standard of informatics (Hagiya, 2015) and additional topics related to general computing education (Kawamura, 2008). The BOK contains 90 topics classified by 21 domains as represented in Table 2. The BOK is used to precisely define educational achievement of each program. The numbers within the parenthesis are the number of topics belonging to the section or the domain.

We adopted the same definition of level and BOK throughout the survey types A to D in order to enable mutual comparison of the different survey types. Such comparison is important to understand relationship among different survey types.

In case of survey type D, a department or a course responds to the survey.

Table 1
Knowledge and Skill Level Definition

Level	Knowledge Level Definition	Skill Level Definition
0	Not taught (unnecessary or already taught at general computing education)	
1	Not taught because of the time limitation or because the level of the contents is too high	Taught at class with simple exercise
2	Taught at class. Students know each term	Taught at class with some exercise. Students can perform the topic if detailed instruction is provided
3	Taught at class. Students can explain the meaning of each term	Taught at experiment with more complex exercise. Students can perform the topic with simplified instruction
4	Taught at class. Students can explain relationship and/or difference among related terms	Students perform combined research project containing the topic so that the students can autonomously perform the topic
5	Taught at class or graduation research project. Students can teach related domain or subject of the terms to the others	Students perform combined research theme containing the topic. Students can teach how to perform the topic to others

Table 2
Common BOK Organization

Source	Section	Domain
J07-GEBOK	General Education	Informatics in General Education (9)
Reference Standard of Informatics	(A) General Principles of Information (6)	
	(B) Principles of Information Processing by Computers	Information Transformation and Transmission (4), Information Representation, Accumulation and Management (4), Information Recognition and Analysis (4), Computation (6), Algorithms (8)
	(C) Technologies for Constructing Computers that Process Information	Computer Hardware (3), I/O Device (4), Fundamental Software (3)
	(D) Understanding Humans and Societies that Process Information	Process and Mechanism for Information Creation and Transmission (2), Human Characteristics and Social System (3), Economic System and Information (2), IT-based Culture (2), Transition from Modern Society to Post Modern Society (2)
	(E) Technologies and Organizations for Constructing and Operating "Systems" that Process Information in Societies	Technics for Information System Development (7), Technics to Obtain Information System Effect (6), Social System Related to Information (2), Principle and Design Methodology for HCI (4)
	Competence	Professional Competency for IT Students (3), Generic Skill for IT Students (6)

2.3. *Survey Process*

We prepared the survey in October 2016. We defined the survey questions and set up the web-based survey system (Kakeshita and Ohtsuki, 2011). We utilized the web-based survey system since we did not exactly know the actual organization for this survey in advance. After preparing various document such as user manual and detailed explanation of the survey questions, we sent the formal request letter to all universities in Japan with a reference letter from the Japanese Ministry of Education in order to increase the response rate.

The survey was executed for two months starting at the beginning of November 2016. Each survey responder must first register to the web-based system and then answer the questions listed in Section 2.1. We also provide FAQ and independent answers for the questions from the responders.

After closing the survey, we reviewed the collected answers and requested the responders for possible correction of the incomplete answers.

3. Response Rate Analysis of the Survey

The target of survey type D is a department or a course which provides an educational program to obtain high school teacher's license on IT. Such educational program must be accredited by the Japanese ministry of education. We collected data related to computing subjects and the subjects to teach handling of computer. If there are more than one courses of the teacher training of high school subject "information" on the same campus, each of the course is requested to respond to the survey after the independent registration to the survey web site.

We designated the names of universities, undergraduates, departments (or courses) corresponding to the teaching professionals for the answer of target organizations. The resulting number of responses is shown in Table 3. Here a public university is founded and supported by a local government such as prefecture or big city. We also counted the number of courses from the responses since some universities merged multiple courses within a response. The number of accredited courses is counted from the list of the accredited courses published by the Japanese ministry of education. The surveyed year is the 2016 fiscal year.

Table 3
Number of Responses to Survey Type D

University Type	Number of Responses	Number of Courses	Number of Accredited Courses
National	85	75	107
Public	18	14	17
Private	235	251	397
Total	338	340	521

4. Program Organization

There are three types of education programs for high school teacher's license on subject "Information". The first one is developed within a computing department. The second one is developed within a non-computing department having a computing department within the same university. The third type is developed at a university without computing department. Table 4 represents the number of program for the three cases. We shall analyze the survey result based on this classification.

We collected answers on corresponding subjects for the teaching curriculum of high school subject "information" or the operations for information equipment. The results are shown in Table 5. Most of the subjects are taught as a lecture.

Table 5 shows subjects corresponding to 20 credits of "Subjects related to computing domain" defined in the license law enforcement regulations for the accreditation criteria of the Japanese Ministry of Education.

The remarks on subjects related to computing domain are as follows:

1. Credits earned for more than 20 credits in "Subjects related to computing domain" are included in "Subjects related to computing domain or teaching activity".
2. If you acquire credits in "Information Processing" and "Computer Network Theory" in "Subjects related to computing domain", the required credits for "Subjects related to computing domain or teaching activity" will be 10 or 8 credits depending on the earned credits.
3. "Subjects based on Article 66-6 of the License Law Enforcement Regulations" and "Subjects related to computing domain" can be used for graduation.
4. Credits for "Subjects related to computing domain" can also be earned according to the rule for daytime course.

Fig. 1 represents distribution of the number of experiments in the accredited programs. As shown in the Fig. 1, 32 programs (20.2%) in the computing departments have more than two experimental subjects. However, the number of programs providing experiments decreases at the programs in non-computing department. Particularly there is only one program (1.3%) providing experiments at a university having no computing department. There is a significant difference between computing department and non-computing department will be discussed in the succeeding sections.

Table 4

Classification of Programs based on Supporting Department

Classification	# of Responses
Developed in a Computing Department	158
Developed in a non-Computing Department having Computing Department within the same Unversity	106
No Computing Department with the University	74

Table 5
Subjects related to Computing Domain in the License Law

Subject Category Defined in the License Law	Number of Credits	Subject Name	Required Credit	Elective Credit
Information Society and Information Ethics	20	Social information theory	2	
		Organizational Information Theory		2
Computer and Information Processing (including practice)		Information Processing Basics	2	
		Information Processing	2	
		Information Mathematics		2
		Software Science		
		Planning Science	4	
		Decision-Making Theory		4
Information System (including practice)		Information System Theory	2	
		Information System Construction Theory		2
		Information System Management Theory		2
		Management System Basics		2
Information Communication Network (including practical training)		Computer Network Theory	2	
Multimedia Expression and Technology (including practice)		Digital Design Theory	2	
		Operations Research	2	
Information and Occupation		Information and Occupation	2	
		Business System Theory		2
Required Credits	20	□	20	

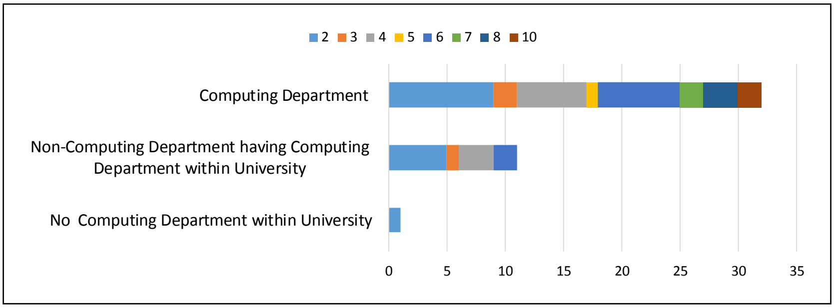

Fig. 1. Number of Experiments included in the Accredited Programs.

5. Quality and Quantity of Educational Achievement

In this section, we outline the educational achievement of the program and the survey results of the education level.

For each of the sections defined in Table 2, we define effort by the sum of the multiplication of the number of enrolled students and the level value of each domain included in the answers. These allow estimating the effort that each institution is spending for a combination of each domain and knowledge/skill.

We first remove outliers of the collected data using the IQR method. IQR (inter-quartile range) is defined by the difference between the first and the third quartile of the collected data.

IQR = Data Value at the 3-rd Quartile – Data Value at the 1-st Quartile

Next, we calculate the value obtained by adding 1.5 times of the IQR to the third quartile. Data above this value are considered outliers. Also, we calculate the value obtained by subtracting 1.5 times of the IQR from the first quartile. Data below this value are also considered outliers. If the data is completely normal distributed, then IQR is standard deviation (SD) multiplied by 1.35. The third quartile is the average SD multiplied by 0.67, so an average SD multiplied by 2.70 plus 1.5 times IQR is the top outlier division. The summary result is shown in Fig. 2. This shows an overview of the areas which educational institutions are focused on.

The knowledge effort and skill effort have some differences, but we find a very high correlation coefficient value of 0.97. The results of sorting the areas in descending order of knowledge effort are shown in Table 7. This is considered to represent the importance of each domain recognized by the educational institution. In addition to this, the effort value of "general IT education" and "generic skills for IT students" are high, but this is due to the lack of teachers who can handle full-fledged information specialized education. The relative decrease in average academic achievement of university students is estimated as the rate of increase in the background.

While the effort ratio to teach general education is high, but the average achievement level is not high which compared with other regions. This reason is that the general IT education is often taught in the first or second academic year for all college students.

The effort ratio is greater for "generic skill for IT students" is large, and the average of the achievement levels for this skill is higher compared to other regions. This reason

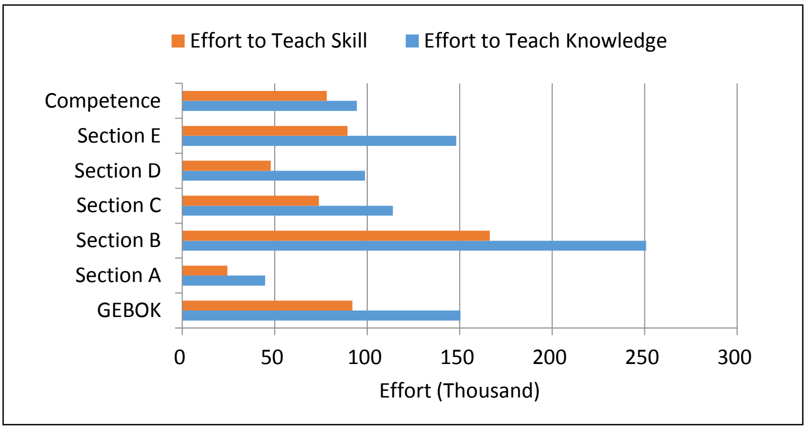

Fig. 2. Effort distribution to Teach Knowledge and Skill.

Table 7
Effort to Teach Knowledge and Skill of Each Domain

Domain Name	Effort to Teach Knowledge	Effort to Teach Skill
General IT Education	150,361	92,050
General Principles of Information	44,729	24,311
Information Transformation and Transmission	43,112	26,518
Information Representation, Accumulation and Management	56,562	38,215
Information Recognition and Analysis	33,918	23,651
Computation	49,004	31,440
Algorithms	68,280	46,503
Computer Hardware	30,166	20,079
I/O Devices	44,562	28,090
Fundamental Software	39,087	25,731
Process and Mechanism for Information Creation and Transmission	21,695	10,849
Human Characteristics and Social System	24,231	11,234
Economic System and Information	14,164	6,184
IT-based Culture	21,658	11,776
Transition from Modern Society to Post Modern Society	17,103	7,801
Technics for Information System Development	54,459	39,503
Technics to Obtain Information System Effect	36,878	18,900
Social System Related to Information	29,805	13,752
Principle and Design Methodology for HCI	27,009	17,152
Professional Competency for IT Students	33,488	23,749
Generic Skill for IT Students	60,963	54,332
Information processing, calculation, data analysis	389	64

is that the generic skills are often educated in college subjects including graduation research.

Next, we shall analyze the quality of education. Figures Fig. 3-1 through Fig. 9-2 show the distribution of the number of students at each knowledge and skill levels for each section defined in Table 2. Since the total number of students is different, we shall show the ratio of the number of students. The distributions are shown in three cases defined in Table 4. The purpose of the comparison is to clarify the impact of the computing department, since computing departments are expected to have more teaching resource, such as teaching staff and computing facility, than other departments.

Fig. 3-1 and Fig. 3-2 represent the distributions for General IT Education. The knowledge levels in Fig. 3-1 are concentrated between two and four, especially in the computing department, where the level four is the highest. In the skill level shown in Fig. 3-2, nearly 40% of the Case 2 show level 0, while Level 2 is the highest for Case 3. This also demonstrates advantage of computing department even for general IT education.

Fig. 4-1 and Fig. 4-2 represent the distribution of student numbers against knowledge and skill levels achieved in the three cases of the section A of the reference standard. Readers can find that the mean values are similar in the three cases, but Case 1 has a larger standard deviation than Case 2 or Case 3. Case 1 is also the highest at level 4 in Fig. 4-1 and Fig. 4-2.

Case 1: Computing Department
Case 2: Non-Computing Department having Computing Department within University
Case 3: No Computing Department within University

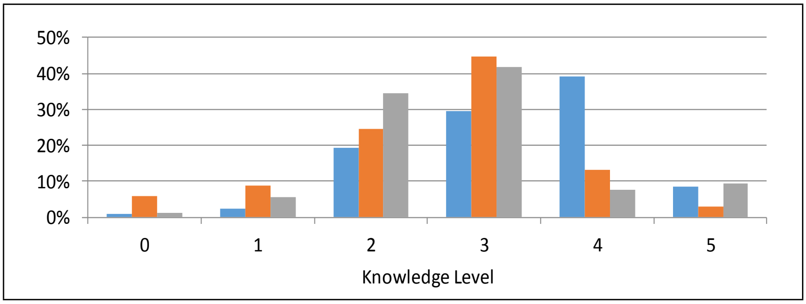

Fig. 3-1. Knowledge Level Distribution (General IT Education).

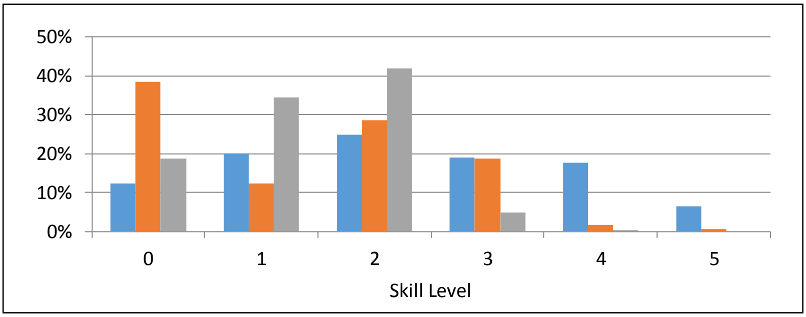

Fig. 3-2. Skill Level Distribution (General IT Education).

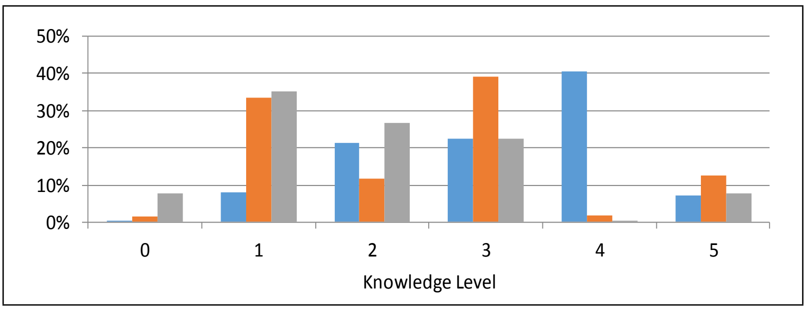

Fig. 4-1. Knowledge Level Distribution (Section A of the Reference Standard).

Fig. 5-1 and Fig. 5-2 show a comparison of knowledge and skill level distributions on the principles of information procession by computers (Section B of the Reference Standard) for the three cases. The distribution of knowledge levels in Fig. 5-1 shows a

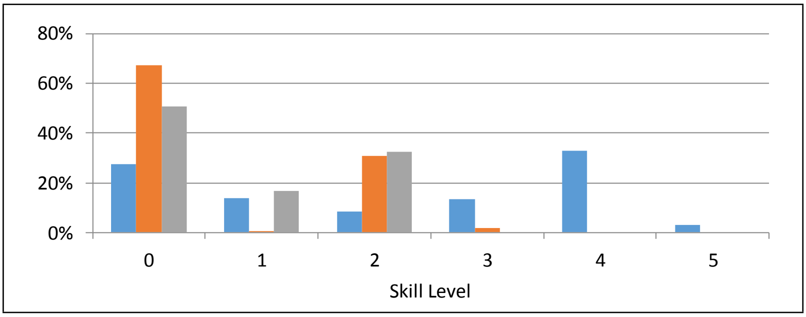

Fig. 4-2. Skill Level Distribution (Section A of the Reference Standard).

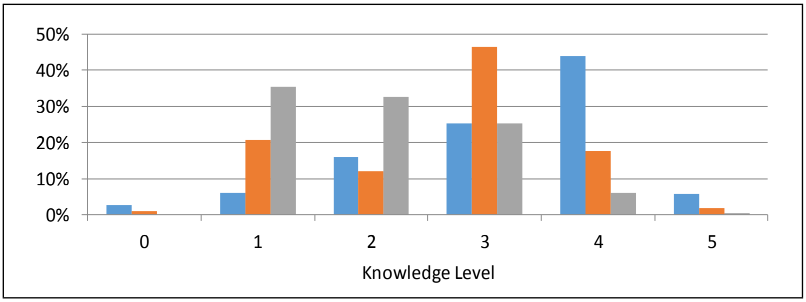

Fig. 5-1. Knowledge Level Distribution (Section B of the Reference Standard).

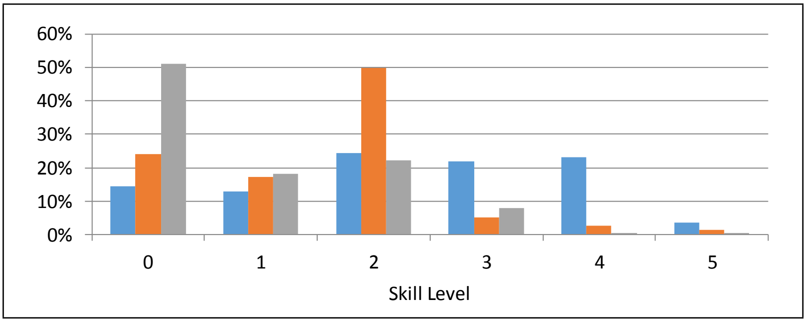

Fig. 5-2. Skill Level Distribution (Section B of the Reference Standard).

similar trend, but 40% of Case 1 supports Level 4. There is a big difference in the distribution of skills in Fig. 5-2. In Case 1, 50% of the students have achieved a skill level greater than 3, but in Case 2 and Case 3, 50% or more of the students have skill level 0. This is considered an impact of the computing department.

Fig. 6-1 and Fig. 6-2 show a comparison of knowledge and skill level distributions on the technologies for constructing computers that process information (Section C of the Reference Standard). At the knowledge level shown in Fig. 6-1, more than 50% of Case 2 and 3 are level 2, while the peak of Case 1 is level 4. The distribution of skill lev-

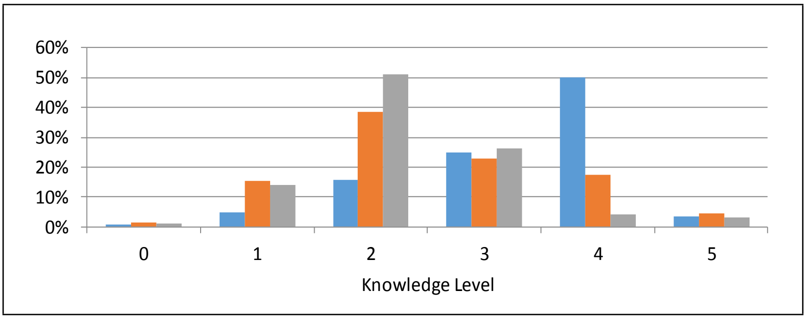

Fig. 6-1. Knowledge Level Distribution (Section C of the Reference Standard).

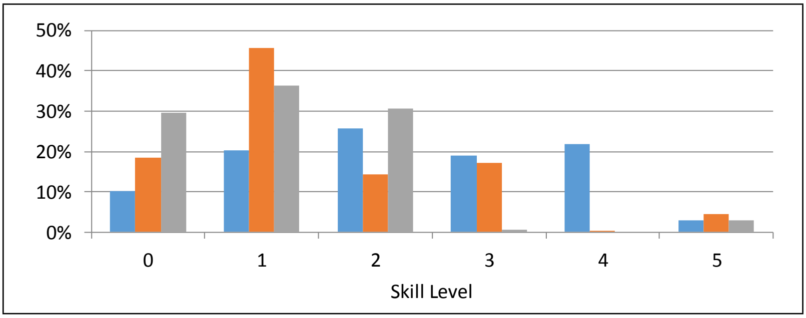

Fig. 6-2. Skill Level Distribution (Section C of the Reference Standard).

els in Fig. 6-2 shows a similar trend. Achievement of both Knowledge and Skill Levels are higher in Case 1 than the other two cases.

Fig. 7-1 and Fig. 7-2 show a comparison of the distribution of knowledge and skill levels about understanding humans and societies that process information in the three cases (Section D of the reference standard). In the knowledge level shown in Fig. 7-1, 35% of Case 1 shows Level 4, and the skill level shown in Fig. 7-2 shows 30% of Case 1 is at level 4. In both skill and knowledge, the readers can observe that Case 1 has a higher level.

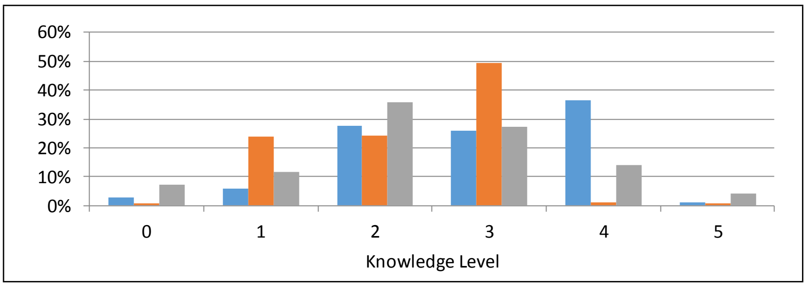

Fig. 7-1. Knowledge Level Distribution (Section D of the Reference Standard).

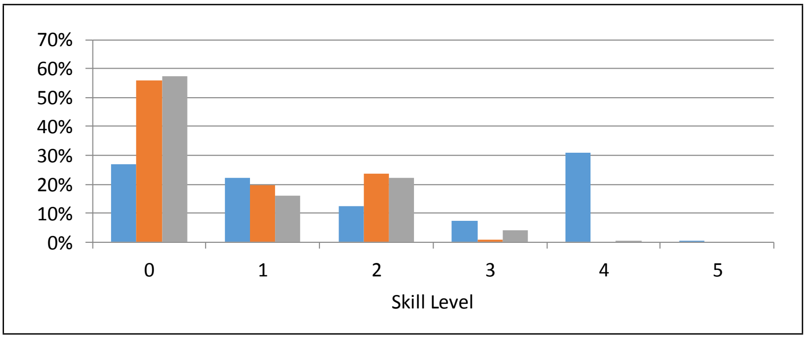

Fig. 7-2. Skill Level Distribution (Section D of the Reference Standard).

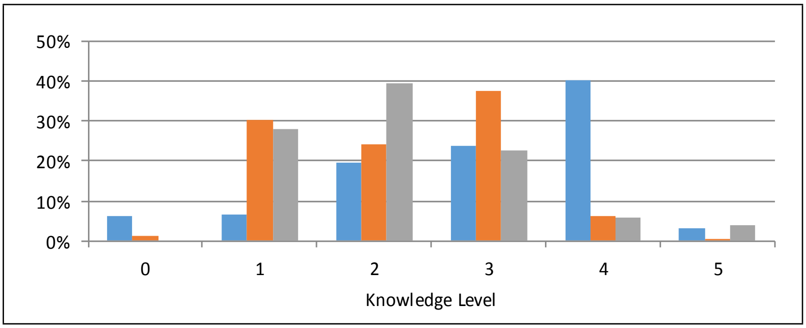

Fig. 8-1. Knowledge Level Distribution (Section E of the Reference Standard).

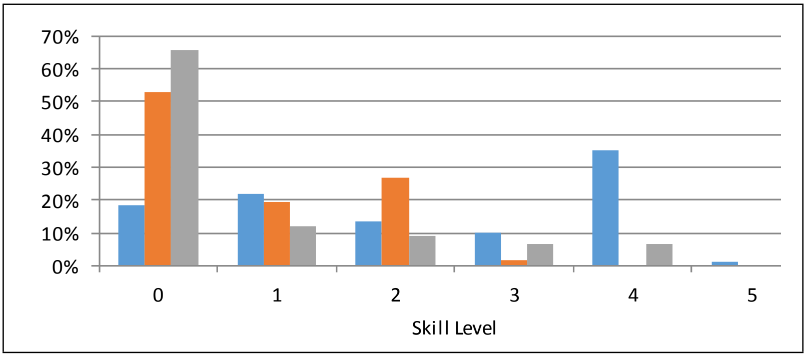

Fig. 8-2. Skill Level Distribution (Section E of the Reference Standard).

Fig. 8-1 and Fig. 8-2 show a comparison of the distribution of knowledge and skill levels for technologies and organizations for constructing and operating “systems” that process information in societies (Section E of the reference standard). At the knowledge level in Fig. 8-1, 40% of Case 1 indicates Level 4, and the skill level in Fig. 8-2 also indicates 35% of Case 1 at Level 4. Also, in Cases 2 and 3, we found that more than 50% of the students are not taught anything about skills.

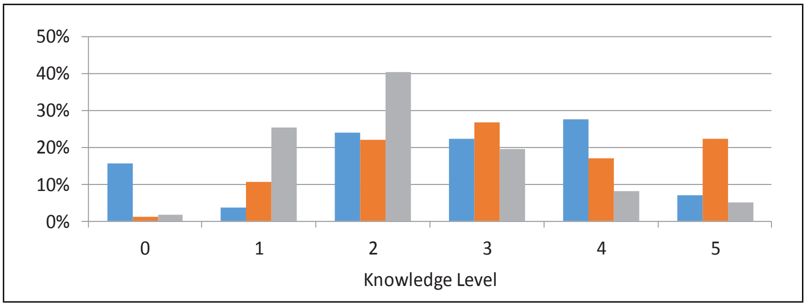

Fig. 9-1. Knowledge Level Distribution (Competence of the Reference Standard).

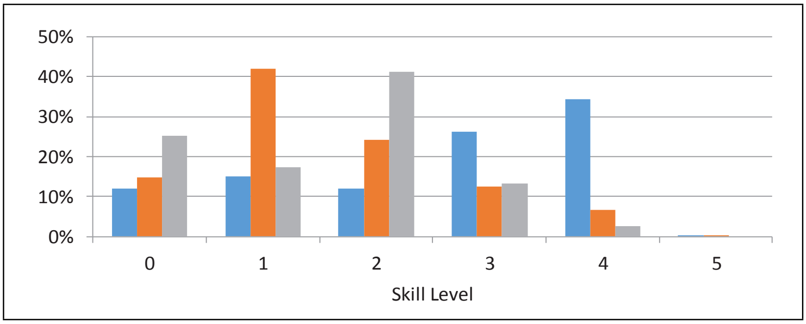

Fig. 9-2. Skill Level Distribution (Competence of the Reference Standard).

Fig. 9-1 and Fig. 9-2 show a comparison of the knowledge and skill level distributions of competence section of the reference standard of informatics. In Fig. 9-1, 28% of Case 1 has reached to level 4, whereas Case 3 has a lower peak of 39% at level 2. In Fig. 9-2, while 35% of Case 1 is at level 4, the peaks in Case 2 and Case 3 are level 1 and 3 respectively, which are significantly lower than Case 1.

As the reader can understand from Fig. 3-1 to Fig. 9-2, the educational achievement of Case 1 is generally higher than Case 2 and Case 3. This is considered an effect of the computing department, as the computing department usually hires more computing professionals as faculty members. This shows the importance of teachers in charge of computing education.

6. Students

Fig. 10 shows the distribution of the standard academic year of the subject "information" for teacher training. In most cases, the teacher training course is provided for 1–3 or 1–4 academic years.

In the distribution of student quota at each educational program, the sum of the student quota is 20,854. It indicates the maximum number of students who can obtain the

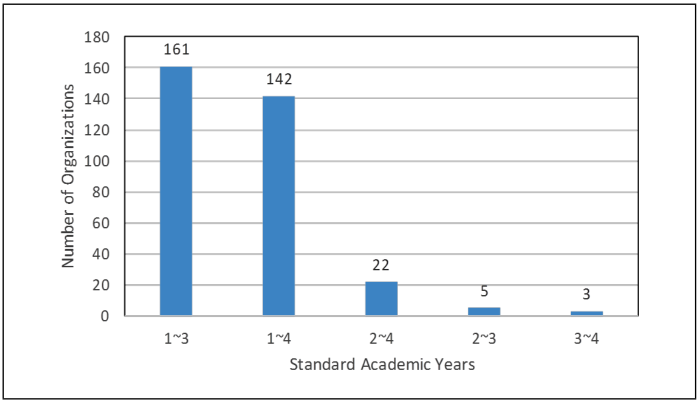

Fig. 10. Standard Academic Years N = 338.

teacher's license at each program. We also collected the number of enrolled students at each program. The number of enrolled students represents the average of the last three years. The total number of students who obtained the license is 369 (275 males and 94 females). This means that most of the program issue very small number of teacher's license compared to their quota.

Fig. 11 shows the number of enrolled students at each program. The number of enrolled students at each program never exceeds 10 so that all education programs are very small. There are many programs with no enrolled students. Some of the programs quitted to issue teacher's license. Total student enrollment is 5,011 (863 males and 4,143 females). The readers can observe that the number of students obtained teacher's license is quite few compared with the number of student enrollment. This

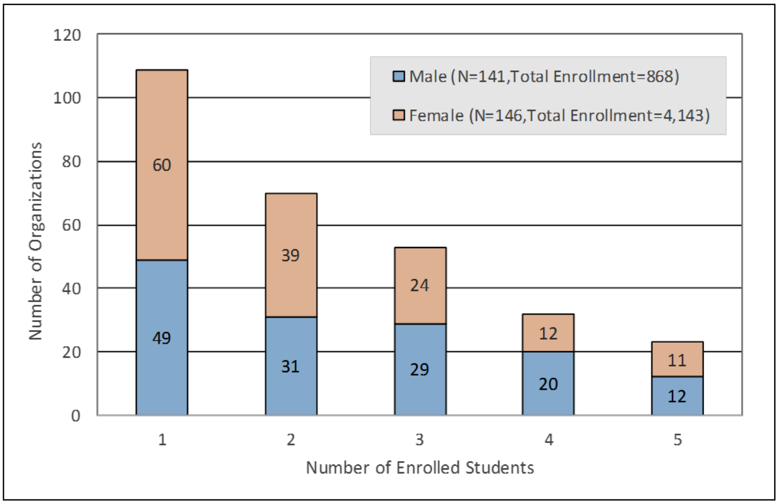

Fig. 11. Student Enrollment.

is mainly because that the number of open positions of IT teachers at high school is quite limited.

Table 8 represents students' career selection after graduation. Students who took a job as a teacher of the subject "information" including a temporary adoption remained a total of 198 persons (1.1%). On the other hand, 1,290 students (7.4%) took a job as a teacher other than the subject "information". In addition, 3,173 students (18.3%) enter graduate schools, while 11,371 students (65.5%) are hired at a company or a government.

Although the number of teachers with high IT skill and experience is limited at high school, the new open position for the high school teacher of subject "Information" is very small as explained above. The reason is that the number of teachers to teach "Information" is typically only one at each high school and there are many cases that a high school teacher with license of other subjects such as mathematics is already teaching subject "Information" at high school. Thus, a student often obtains double license such as subject "Information" and "Mathematics" in order to increase possibility to get job at high school. It is expected to improve such situation since computing subject is one of the core knowledge and skill at the 21-st century.

Table 8

Student's Career Selection after Graduation

Career Selection	Number of Students	Ratio (%)
High School Teacher of Subject "Information"	198	1.1
High School Teacher of Another Subject	1,290	7.4
Graduate School of Computing Discipline	1,803	10.4
Graduate School of other Discipline	1,370	7.9
Hired at Company or Government	11,371	65.5
Others (including unknown)	1,332	7.7
Total	17,364	100

Table 9

The total number of persons and representative class

Type of Faculty Member	Total Number of Persons	Number of Faculty Graduated IT Department	Number of Faculty Members Majored in Informatics	Total Number of Classes in Charge
Full-Time Teacher without a Term of Office	319	214	241	250
Full-Time Teacher with Term of Office	104	52	74	95
Admiral · Cumber some Staff (in-House Teacher)	130	74	86	120
Part Time Lecturer (Outside School)	231	140	166	218

7. Teaching Staff

Table 9 represents the total number of persons and the number of representative class of person in charge, assistant of the subject “information” teacher training. We find teachers who did not graduate a department majored in computing discipline or whose current major is not informatics. Faculty development for these teachers is quite important.

8. Computing Environment

Table 10 represents the answers of the educational computer system utilized by the educational program. It should be noted that 106 programs (31.4%) do not have educational computer system. Since we have found that the non-existence of the educational computer system greatly affects students’ skill level (Kakeshita, 2018), improvement is strongly recommended.

Table 11 represents the utilization of student PC at the programs. Most of the courses do not require or recommend their students to purchase or possess PC for use in the classroom.

Table 10

Utilization of Educational Computer System

Selection	Number of responses
Shared Use of Educational Computer System at University	113
Shared Use of Campus Educational Computer System	39
Shared Use of Educational Computer System at Faculty	22
Using the Department’s Educational Computer System	47
There is an Educational Computer System in the University, but They are not Used for the Education	11
There is no Educational Computer System in the University	106

Table 11

Utilization of Student PC

Utilization	Number of Responses
All students of the university must have PC	25
All students of the faculty must have PC	24
All students of the department/course must have PC	20
Students are recommended to purchase PC	25
Purchasing of Student’s own PC is optional	244

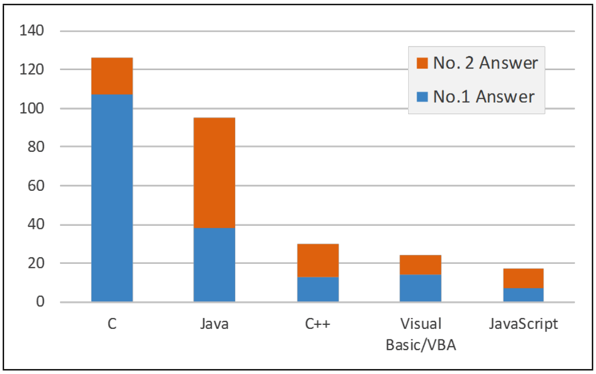

Fig. 12. Popular Educational Programming Language.

11 programs do not use existing educational computer system. Most of these programs require students to purchase their own PC. There is no educational computer system at 106 universities. Further investigation of the computing education is required for the latter case.

We asked to answer educational programming languages which the courses are using. The programming languages are selected such that the student reached a level beyond the level to understand a simple program written in that language. Fig. 12 shows the top-5 languages with the highest and the second highest student achievement level at each program.

9. Other Effort Related to Computing Education at Individual Programs

9.1. *Future Plans*

We collected the answers from different departments about their future plan during the survey. We shall introduce some of them.

Some departments are preparing to set up subjects such as “digital marketing” and “digital business modeling” related to “business” and “information”. Some reorganize the Information Engineering Department and the Electrical and Electronic Engineering Department into the “Electronic Information Systems Engineering Department”, revise the curriculum considering recent advancement of AI, IoT, Big Data, etc. Some establish Big Data Course. Many departments have a plan of curriculum revision to accommodate recent technology change.

As a concrete example, there is a case that reorganized in Science and Engineering Faculty to create intelligent information system course in 2017, so that the students can learn the state-of-the-art technology such as artificial intelligence that can learn various calculations such as numerical analysis and optimization from basic principles. There was also a department that nurtured human resources that would be the driving force that drives the center of society through education aimed at incorporating it. In addition, there is a department to consider whether to use C or Java as the main language, and to consider not only PHP but also Ruby and Python as CGI.

9.2. *Distinctive Practices*

Common features of each educational program include accreditation from JABEE (Japan Accreditation Board for Engineering Education) in many departments, designing curriculum based on ACM/IEEE Computing Curriculum Guidelines and J07 Computing Curriculum Standard developed by IPSJ (Information Processing Society of Japan). There are also departments that discuss high school-high school collaboration and some departments provide educational materials and IT materials for elementary and junior high schools.

In addition, some introduce a program of informatics into general education, arrange programming languages to be able to learn in cooperation from 1 to 3 academic years. There are some departments providing simultaneous teaching license of "information" and "mathematics". There was something we could do to improve the educational program.

Furthermore, some departments are promoting computing education by introducing e-learning by Moodle etc. There were cases where qualified instructors were enrolled and promoting the acquisition of "IT passport" or "P inspection grade 2".

As a concrete example, some departments set importance on related subjects such as big data, data mining, security, and established the next-generation robot laboratory, which enriched the subjects of mathematics, especially statistics, as the foundation, and collaborated with companies. A department actively promotes research and acquisition of external funds. The Ministry of Education, Culture, Sports, Science and Technology (MEXT) has been adopted as a collaborating university in the field of security in the "Formulation of Information Technology Human Resources Development Center Supporting Growth Areas (enPiT)". Based on this project, some departments have newly established one PBL-type subject for third-year undergraduate students from 2017 and reinforced practical education on big data processing, AI, and cloud technology.

In order to learn software development examples, some departments offer classes with part-time lecturers who were active in IT related companies, and some departments that encouraged collaboration with companies and active participation in programming contests.

9.3. *Collaboration with Computing Qualification*

There are many cases that the curriculum is designed so that many students can take the Information Technology Engineer Examination, which is the largest national examination for IT engineers. Some departments also support commercial qualification such as Microsoft Office Specialist, Microsoft Technology Associate, IT Passport, Basic Information Technician, Network Specialist, CCNA, Web Creator, LPIC, MOS etc. They introduce part to class contents, hold special course, establish course corresponding to morning examination exemption system of basic information technology examination, and offer “IT passport exercises” in sub measure. Some conduct online exams for MOS in the on-campus PC training room, or partner with Cisco Systems Inc. to offer elective courses for acquiring CCNA (CiSCO Certified Network Associates) certification.

10. Concluding Remarks

The findings found through Study D are listed below. We think that the efforts to solve the problems 2 and 5–7 are important in the future:

1. We obtained 338 responses to survey type D for the IT education to obtain high school teacher’s license on IT “Subject” Information”. The ratio of the courses that responded to the survey D among the accredited courses that can acquire a high school subject “information” type of license is 65.3%. The ratio at national university is 70.1%, at public university is 82.4%, and at private university is 63.2% respectively.
2. 30% of the respondents in Survey D overlap with Survey type A majored in the computing discipline, but there are also the cases at which teacher training courses of subject “Information” are provided at non-IT departments. Student achievement is generally higher at programs provided at computing departments.
3. The effort for general computing education is large, but the average achievement level is not so high compared with other domains.
4. The effort for “generic skills that students studying informatics should acquire” is large, and the average achievement level for skills is also high compared to other domains.
5. The total number of student quotas in the teaching curriculum of the subject “Information” is 20,854, but the number of enrolled students in the teacher training course in the first academic year is 5,006, and the number of license holders is only 369. Many students leave on the way because the number of teachers employed in the subject “information” is extremely small.
6. Teachers of the subject “information” remain as 198 students as a course of teaching professional graduates (including teacher training courses other than “information”) in FY2007. There are 1,290 high school teachers other than “information”. There are 3,173 students going on to graduate school, 11,371 are employees, 1,332 are unknown. The students acquiring a license for the subject “information” secured the competitiveness at the time of hiring teachers by acquiring multiple licenses.
7. 31.4% (106 cases) of the departments and courses do not provide educational computer systems at the university.

The data collected in this survey is useful for understanding the detailed status at the timing immediately before the re-accreditation of the teacher's courses scheduled to start from 2020. In the future, it is desirable to conduct another survey after the re-accreditation in order to analyze the difference. By analyzing other survey data such as survey C, it can be expected to clarify the characteristics of educational contents of "operation of information equipment".

For the teacher training program of the subject "Information", there are provisions of Article 5 of the Education Employee License Law Enforcement Regulations and Article 66-6 by the ministry of education in Japan (Operation of Information Equipment). However, the specific curriculum design is left to independent departments. Based on the formulation of "reference standards for informatics", it is expected that future curriculum standards for the subject "information" will be presented in a manner that is associated with the same reference standard.

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