Olympiads in Informatics, 2019, Vol. 13, 57–79

DOI: 10.15388/ioi.2019.05

Survey and Analysis of Computing Education at Japanese Universities: Non-IT Departments and Courses*

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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 at non-IT departments and faculties whose major subject is not computing. 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 994 answers through the survey. At least 87,000 non-ICT students are taking computing education in Japan. Although computing education is carried out at every major academic discipline, teaching effort greatly differs depending on the academic discipline. We also find shortage of teaching staff for computing education. The analysis result will be an essential input to develop reasonable curriculum guidelines and accreditation criteria to improve computing education at non-IT departments.

Keywords: computing education, web-based survey and analysis, college level education, quality assurance in education.

1. Introduction

Information Technology (IT or ICT) is regarded as an essential infrastructure of the modern society. IT is also expected as a driver for business and/or social innovation at many countries. For example, EC refers to such skill as e-Skills and works on promoting the development of e-Skills in EU countries (EC, 2007). College level computing education is essential to develop citizens and IT professionals having enough knowledge and skill on IT. Such computing education is required for students whose major is not

* This paper is a revised and extended version of the following paper written by the same author. T. Kakeshita, "National survey of Japanese universities on computing education: Analysis of non-IT departments and courses", in Proc. 12-th International Conference on Digital Information Management (ICDIM 2017), 81-86, 2017.

IT (Urban-Lurain, 2000) as well as for the students majored in IT. Furthermore, many countries including Japan are recently starting computing education from elementary school (Computing at School, 2008; K-12 Computer Science Framework).

Considering the above background, computing education is essential at modern universities. There are four types of computing education in Japanese universities. The situation is expected to be the same at other countries.

A. Computing education at a department or a course majored in computing discipline.
B. Computing education at a non-IT department or a course, whose major is not IT or computing, as a part of their major field of study.
C. General computing education for all students at a university or a faculty typically at the first or second academic year.
D. Computing education for the students willing to obtain high school teacher license on computing subjects.

We conducted a national survey of Japanese universities on computing education in 2016 (Kakeshita, 2017). The survey is composed of five survey types A through E. Among them, survey types A to D correspond to each type of computing education described above. The survey type E is executed for educational computer system which is a fundamental infrastructure for various types of computing education. Our survey is actually the first national survey on this subject in Japan, since there was no widely accepted definition of computing education.

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 so that the Japanese government accepted this as a definition of computing education.

In this paper, we report and discuss the result of the survey type B for computing education at non-IT departments and courses. The purpose of this survey is to analyze and understand the current achievement of computing education at Japanese universities from various aspects including program organization, quality and quantity of educational achievement, students, teaching staff and computing environment.

The ultimate goal of this research is to develop reasonable curriculum guidelines and accreditation criteria to improve computing education at non-IT departments. Fundamental understanding of the achievement of computing education is necessary to achieve this goal. Such effort is necessary since the importance of computing education is increasing in the modern society.

We have already published the survey outline in (Kakeshita, 2017). The results of other survey types were published separately (Kakeshita, 2018; Ohtsuki, 2017; Sumi, 2017; Takahashi, 2017). Information processing society of Japan (IPSJ) utilizes the survey result to develop the new J17 curriculum standard (Information Processing Society of Japan, 2018) for computing education in FY2017. The Japanese Ministry of Education (MEXT) will utilize the survey result to improve the national policy of computing education.

2. Related Work

International or nationwide comprehensive surveys on the status of some educational subject tend to be carried out regarding rather well-established subjects such as mathematics and science than relatively new subject as computing and informatics.

TIMSS (Trends in International Mathematics and Science Study) (TIMSS & PIRLS) was firstly executed in 1995, and is one of the representative international surveys aiming at evaluating educational outcomes on mathematics and science domain at elementary and secondary levels. The TIMSS survey contains inquiry into the status of pupils and students' achievement and national curriculums of mathematics and education as well. ACT National Curriculum Survey (National Curriculum Survey) is an example of the nationwide surveys which investigate curriculums of several subjects, such as English language, arts, mathematics, science, that also appear to be well-established as educational subjects.

On the other hand, some examples of the surveys related to computing education are found, however their focus were mostly specialized on some limited aspects of education rather than entire picture of curriculum execution as we presented in this paper.

For example, (Goldweber *et al.*, 2011) reported how social issues of computing were included into computing curricula referring to an international survey of computing instructors. Simon *et al.* (Simon, *et al.*, 2018) presented an examination of the choice of the programming language in introductory programming courses based on parallel surveys conducted at Australian and UK universities. Marshall (Marshall, 2012) showed a comparison of the core aspects of the ACM/IEEE Computer Science Curriculum 2013 with the specified core of CC2001 and CS2008 to identify the changes of the curriculum. This kind of curriculum survey is in common with our survey in terms of their holistic viewpoints. However, the survey we conducted was about the 'actual execution' of the curricula in several universities placed at different countries, which gave unique nature to the survey we conducted.

Through the literature review, we came to find that our survey and comparative analysis have some specific features compared with the related works, and add original value to the survey.

The most apparent features is the comprehensiveness. For instance, the questionnaire of the survey, as we see in the next section, contains both the questions about educational achievement and those about program overview as well.

We have found another example of international survey on educational content concerning computing and informatics domain (Al-Ansari, 2002). However, its focus was entirely on the educational achievement aspect in our term. The survey which was done focusing on both the aspect of computing curriculum (which was covered by educational achievement) and that of educational environment and human engagement (which was covered by program organization etc.) in one time is very unique among relevant surveys.

3. Survey Outline

3.1. *Survey Questions*

The following is the list of questions for survey type B. The list shows that 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.
- Quality and quantity of educational achievement:
  - See Section 3.2 for detail.
- Enrolled students:
  - Regular academic years of computing education.
  - Number of students.
  - 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 personal computer (PC) and its utilization at class.
  - Educational programming language.
- Other topics:
  - Future plan and strength of the program.
  - Utilization of IT certification and/or qualification.
  - Special remarks.

3.2. *Survey of Quality and Quantity of Educational Achievement*

The survey of quality and quantity of educational achievement 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 quality of education.

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

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)

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.

3.3. *Survey Process*

We prepared the survey in October 2016. We defined the survey questions and set up the web-based survey system (Kakeshita, 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 documents 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 survey system and then answer the questions listed in Sections 3.1 and 3.2. We also provide FAQ and independent answers for the questions from the responders.

Each user answers to the survey questions listed in Section 3.1 through a web-based answer sheet as illustrated in Fig. 1. Although the answer sheet is prepared for the survey type A, the answer sheet for the survey type B is similar except that the questions are slightly different. The questions for each survey type can be easily customized by setting up the master database.

Each user answers to the survey of quality and quantity of educational achievement defined in Section 3.2 by uploading an Excel worksheet as illustrated in Fig. 2. Each survey responder is requested to fill the blue cells where each row respectively represents knowledge and skill achievement levels, and the number of enrolled students learning the specified topic.

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

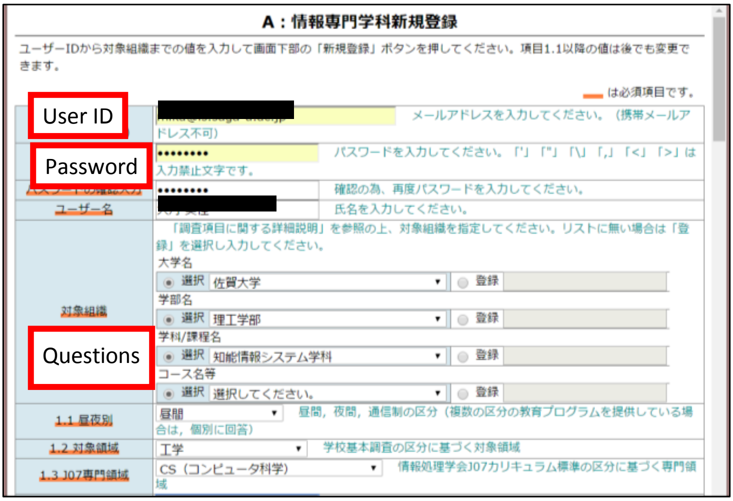

Fig. 1. Web-based Answer Sheet for Each User.

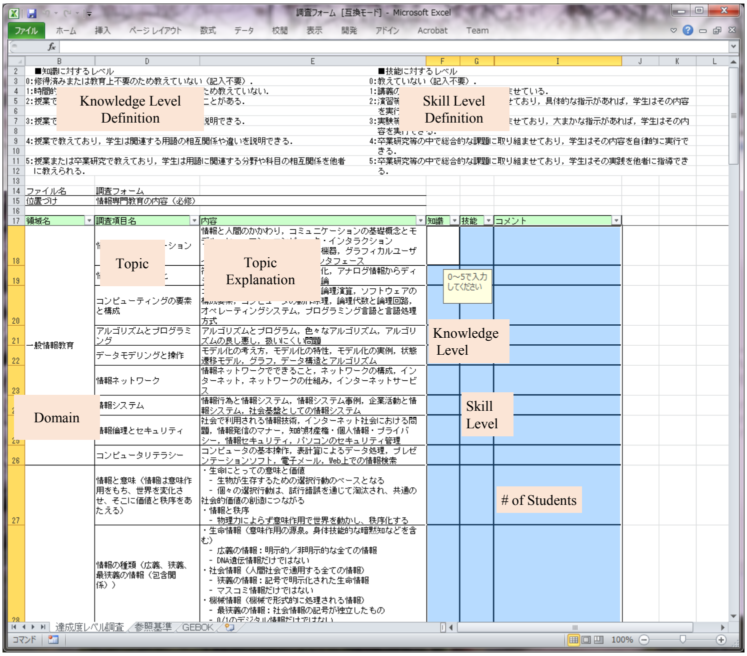

Fig. 2. Answer Sheet using Excel Worksheet.

4. Overview of the Survey Result

The target of survey type B is a department or a course whose major subject is not in the computing discipline. Computing education at such department or course is composed of the general computing education, usually provided by a faculty or a university, and specialized computing education provided by the target department or the course as their major subjects. Survey type B is focus on the specialized computing education. General computing education is analyzed through survey type C (Takahashi, 2017).

4.1. *Number of Responses*

Table 3 represents the number of courses, departments and faculties (including universities) responded to the survey type B. The public universities are the universities run by a local government such as a prefecture or a city.

As can be found from Table 3, we allow a faculty or a university to respond to the survey type B. This is because that the faculty or the university can merge responses from the courses or the departments, since many non-IT departments or courses are expected to provide specialized computing education in the university or faculty.

Table 3.
Number of Responses to Survey Type B

Univ. Type	Course	Department	Faculty or Univ.	Total
National	62	173	67	302
Public	12	34	18	64
Private	67	452	109	628
Total	141	659	194	994

4.2. *Student Enrollment Classified by Major Field of Study*

The school basic survey utilizes 11 major academic disciplines to classify college level education (MEXT, 2017). Table 4 represents the number of students collected through the survey.

87,261 students (13.9% of the university students) are taking specialized computing education. We also find that 61% of the students are taking specialized computing education at the responded departments etc. Although there are many departments not responding to the survey, we can estimate that at least 100,000 students are taking specialized computing education as a part of their major field of study in Japan. Table 4 shows that all major disciplines provide specialized computing education. This fact indicates the importance of computing education.

Table 4
Number of Students Classified by Major Field of Study

Academic Discipline	# of Students		A/B
	A*	B**	(%)
Humanities	4,568	88,246	5.2
Social Science	31,428	204,933	15.3
Physical Science	4,969	18,523	26.8
Engineering	23,151	88,062	26.3
Agriculture	1,824	18,042	10.1
Health (Medicine and Dentisty)	3,438	11,765	29.2
Health (Others)	5,734	58,824	9.7
Home Economics	926	46,475	5.6
Education	2,599	17,787	5.2
Arts	645	18,189	3.5
Others	7,979	56,019	14.2
Total	87,261	626,865	13.9

* **A**: Number of students taking specialized computing education at the responded departments etc.
** **B**: Number of students collected through FY2016 school basic survey (MEXT, 2017).

Another observation from the table is that the ratio of the number of students taking specialized computing education divided by the total number of students greatly differ depending on the major field of study. The ratio indicates the degree of importance of computing education at each discipline. The importance is higher at the departments majored in engineering, physical science and health (medicine and dentistry). We consider that general computing education plays the major role in computing education at the academic disciplines with a lower ratio.

4.3. *Number of Credits for Computing Subjects*

7,883 computing subjects are provided by the responded departments. Among them 5,385 (68.3%) are lectures and 2,498 (31.7%) are exercises. This suggests a realistic ratio of the lecture and exercise to design a computing curriculum recommendation for non-IT departments. 390 departments (33.9% of the responded departments) provide 1 to 4 computing lectures and exercises. While 682 departments provide computing lecture, 316 departments (31.7%) do not. For the case of exercise, 426 departments (42.7%) do not provide any exercise.

Fig. 3 represents the distribution of required number of credits for the computing subjects for each academic discipline. The distribution is illustrated using box plot. The left

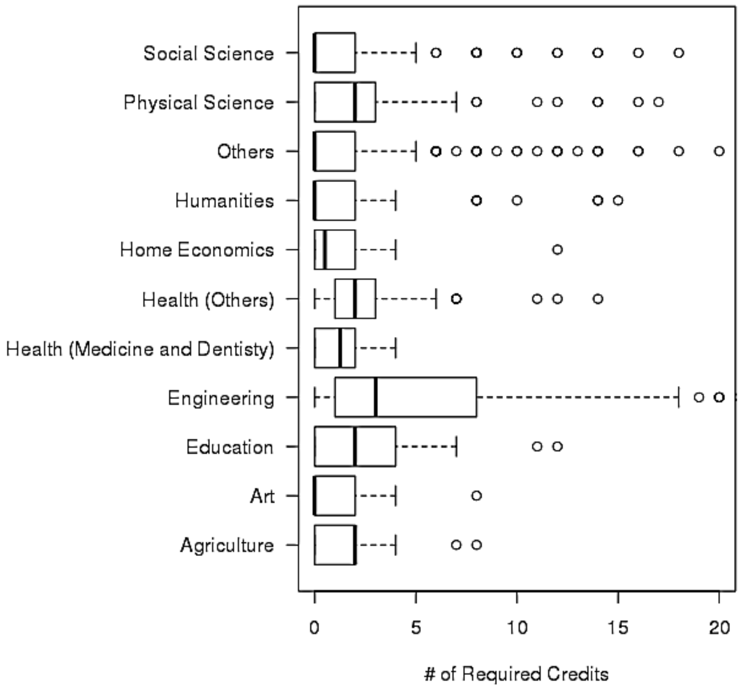

Fig. 3. Number of Required Credits for Computing Subjects.

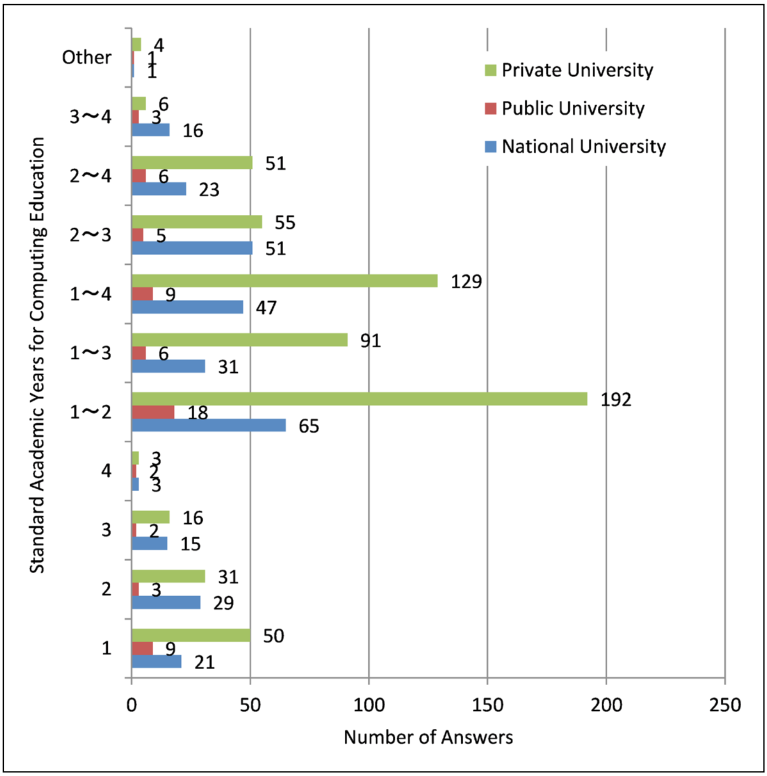

Fig. 4. Standard Academic Years for Computing Education.

and right sides of a box represent lower and upper quartiles of the collected data. The thick line represents the median. The left and right ends of the dashed line respectively represent lower and upper whiskers. Note that some of these values may coincide in the figure. The circles represent outliers. The distribution provides a realistic restriction to design computing curriculum for each academic discipline. For example, typical computing curriculum at non-IT departments is composed of 0 to 5 required credits. It is recommended to design a computing curriculum between 2 to 6 credits depending on the academic discipline to design a widely-accepted one.

Fig. 4 represents distribution of standard academic year for computing education. Computing education at non-computing departments typically starts at the first or second academic year and continues for two to four years. This tendency is essentially the same among national, public and private universities.

5. Educational Achievement

We shall analyze the educational achievement, i.e. quality and quantity of education, in this section. We collected 141 answers of the educational achievement. After classifying the answers for each major field of study, we find that the number of answers is less than or equal to 2 in the case of domestic science, health (medicine and dentistry) and art. Thus we decided to analyze the educational achievements for the major fields other than these three fields.

We define effort of an educational program for a certain topic of the BOK by the multiplication of average level value and the number of students learning the topic. We thus define two types of effort values to teach knowledge and skill.

Fig. 5 represents knowledge effort classified by major field of study. Similar distribution can be obtained for the skill effort. The distribution represents focus of computing education at each academic discipline so that it is recommended to design a curriculum guideline considering the distribution of effort for each BOK section defined in Table 2. The figure is also useful to analyze difference of educational needs for computing education among the disciplines.

Fig. 6 illustrates the cluster dendrogram of the academic disciplines. The dendrogram is computed using hierarchical clustering using similarity of the disciplines. The difference of the heights between the disciplines represents the similarity of the disciplines. The similarity is calculated using the Euclidean distance of the effort distribution of the disciplines. Distance between two clusters is estimated using the complete linkage, i.e. maximum distance of all element pairs of the both clusters. For example, engineering and physical science are most similar so that we can develop a common computing curriculum for these two academic disciplines.

We shall next analyze educational achievement at each discipline. Fig. 7 represents the distribution of the total number of enrolled students for each BOK section and academic discipline. The numbers of the enrolled students are calculated by the sum of the number of enrolled students at each topic of the corresponding BOK section and academic discipline so that the actual values contain double counting of the same student. However we can observe that the disciplines of engineering, social science, and others

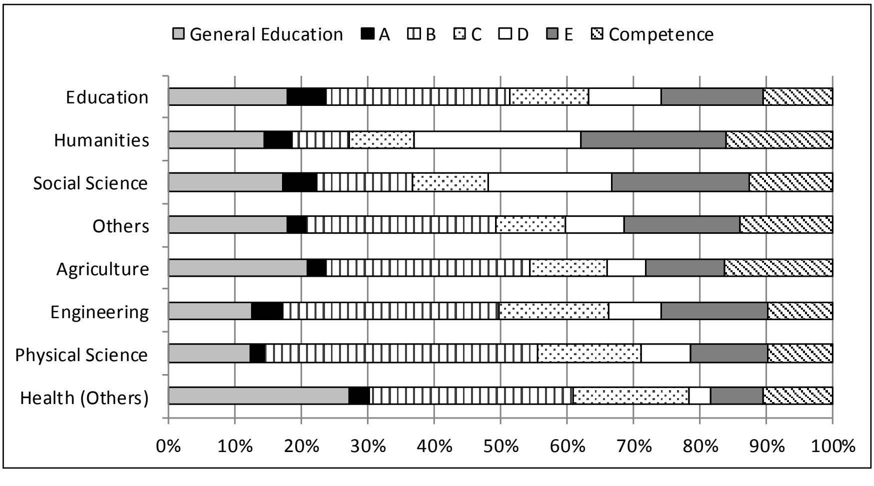

Fig. 5. Knowledge Effort Classified by BOK Section and Academic Discipline.

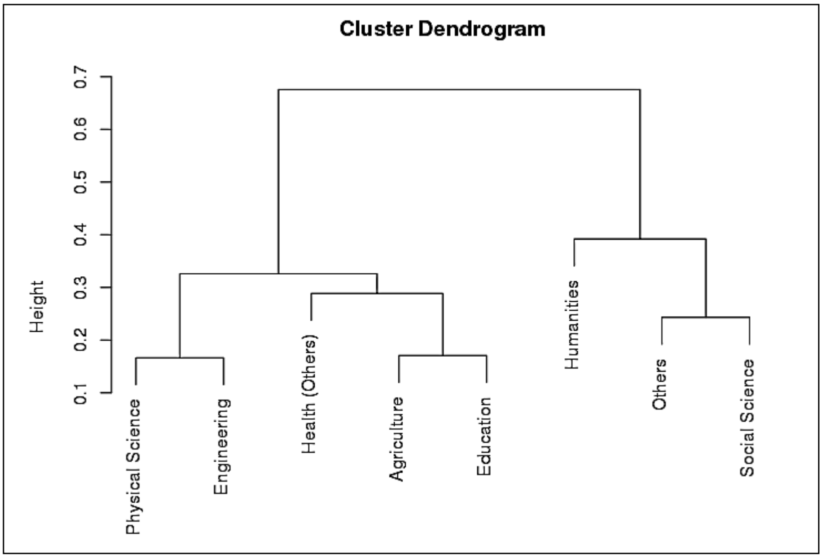

Fig. 6. Cluster Dendrogram of the Academic Disciplines.

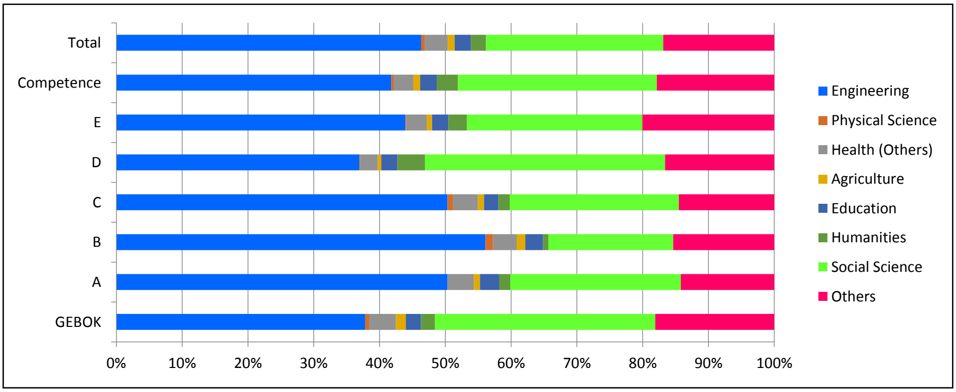

Fig. 7. Comparison of Academic Disciplines on the Total Number of Enrolled Students for Each BOK Section.

are the three largest disciplines of computing education and teach approximately 90% of the students. We shall call these disciplines as major disciplines in this paper.

Fig. 8–Fig. 15 represent average achievement levels (knowledge and skill) of each academic discipline for each BOK section. These figures are useful for each discipline to determine realistic levels for computing education at each BOK section. The readers can refer to Table 1 for the definition of levels.

We can observe that the achievement levels of the three major disciplines are not high compared with the achievement levels of the non-major disciplines. This is because that major disciplines contain various education programs and some of them cannot achieve

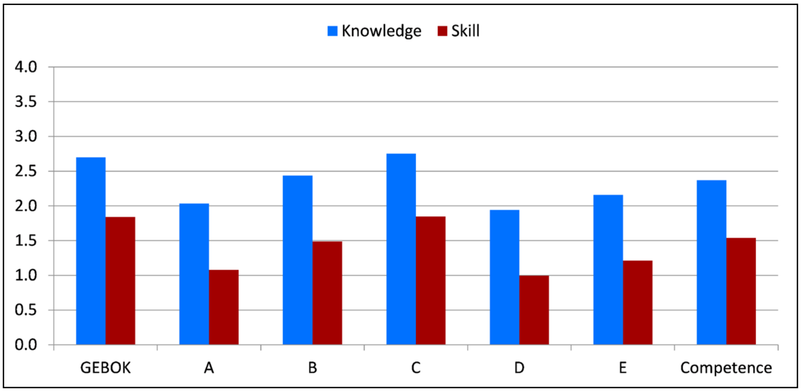

Fig. 8. Average Achievement Levels: Engineering.

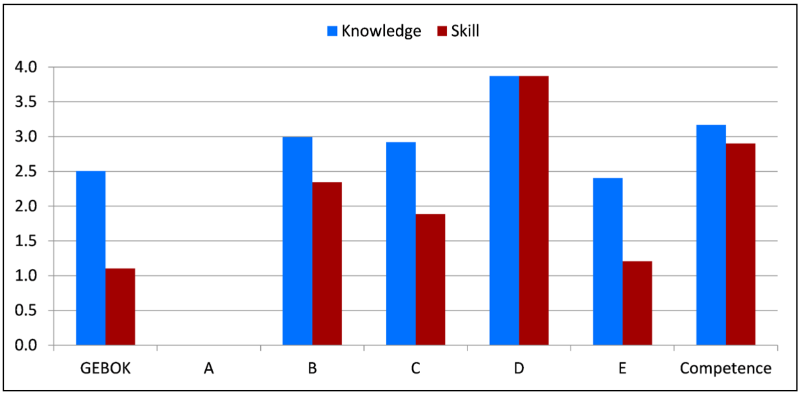

Fig. 9. Average Achievement Levels: Physical Science.

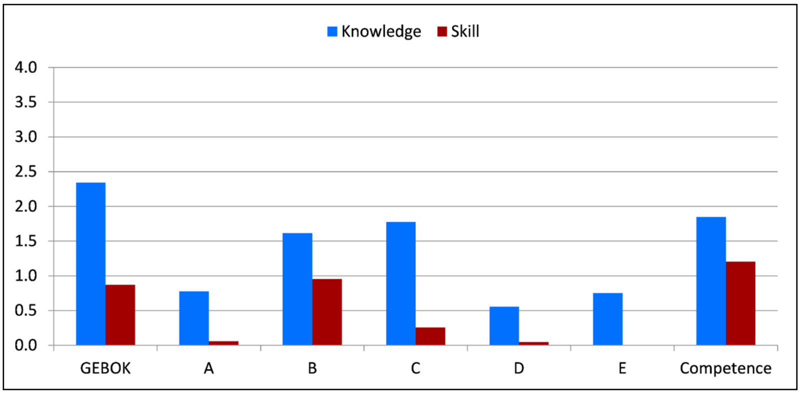

Fig. 10. Average Achievement Levels: Health (Others).

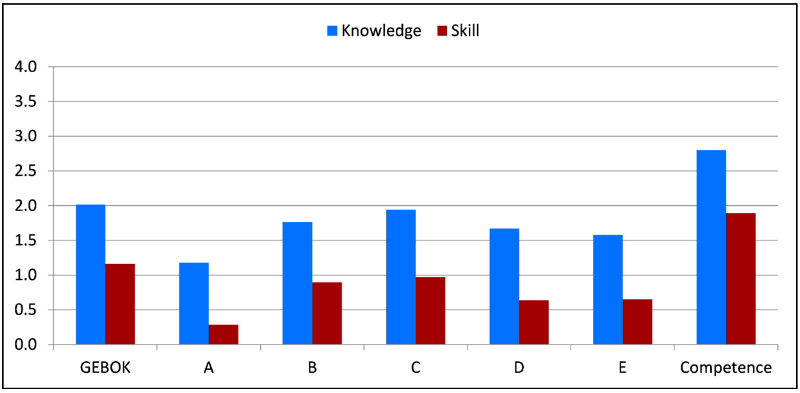

Fig. 11. Average Achievement Levels: Agriculture.

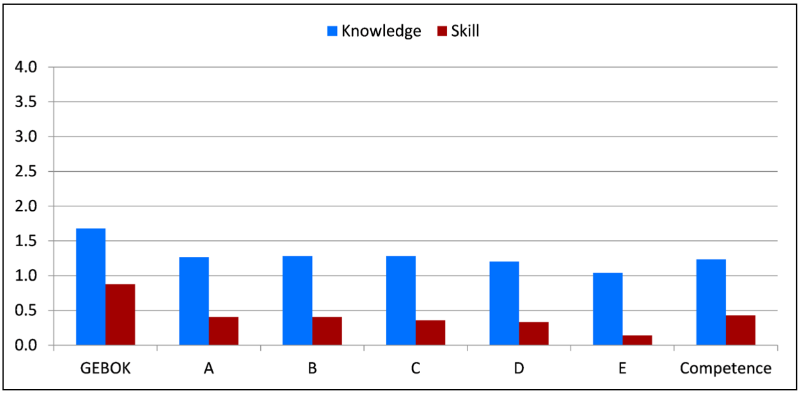

Fig. 12. Average Achievement Levels: Education.

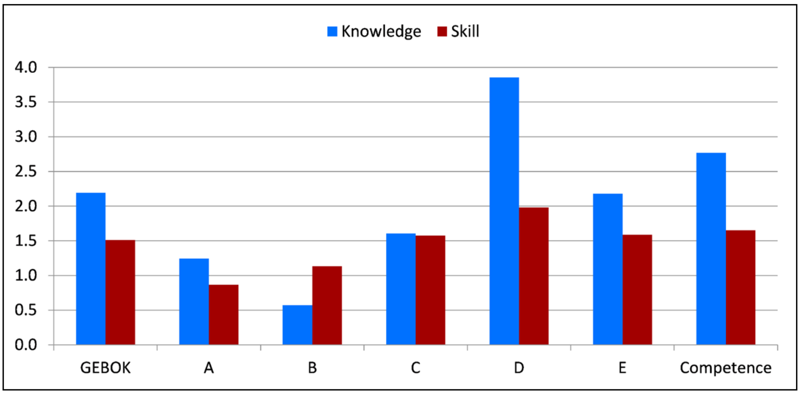

Fig. 13. Average Achievement Levels: Humanities.

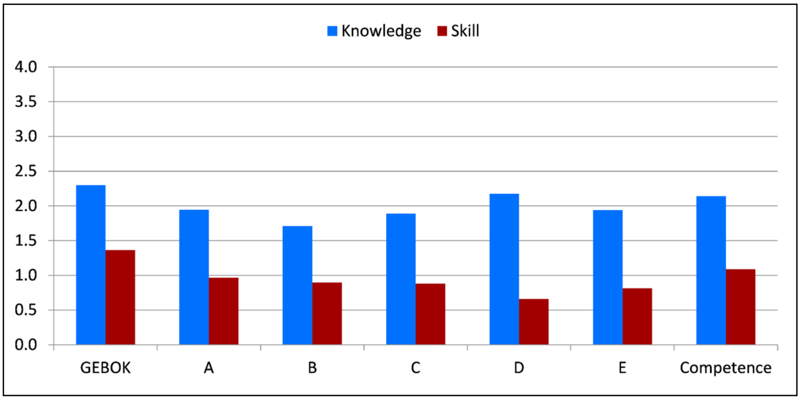

Fig. 14. Average Achievement Levels: Social Science.

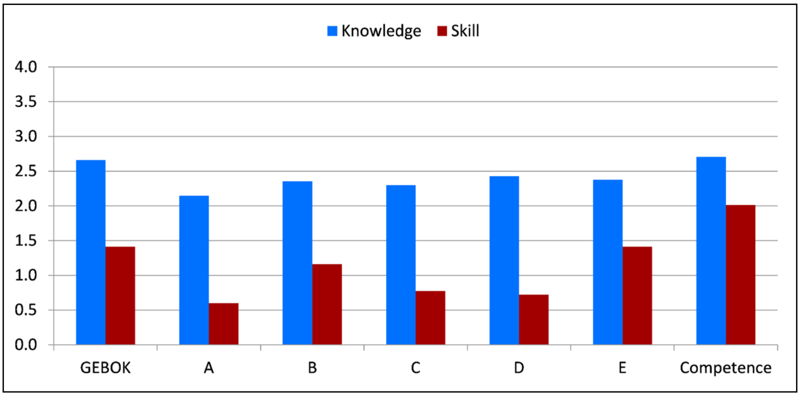

Fig. 15. Average Achievement Levels: Others.

high levels due to restriction of teaching staff and/or budget. On the other hand, some of the computing education at non-major disciplines achieve higher levels at a specific BOK section because they can concentrate education resources for the BOK sections.

The readers can also observe some similarity of the achievement level distribution between the similar disciplines illustrated in Fig. 6.

6. Enrolled Student

6.1. *Distribution of Student Enrollment*

Fig. 16 represents the distribution of student enrollment for the specialized computing education. The number of enrolled students indicates the upper bound of the

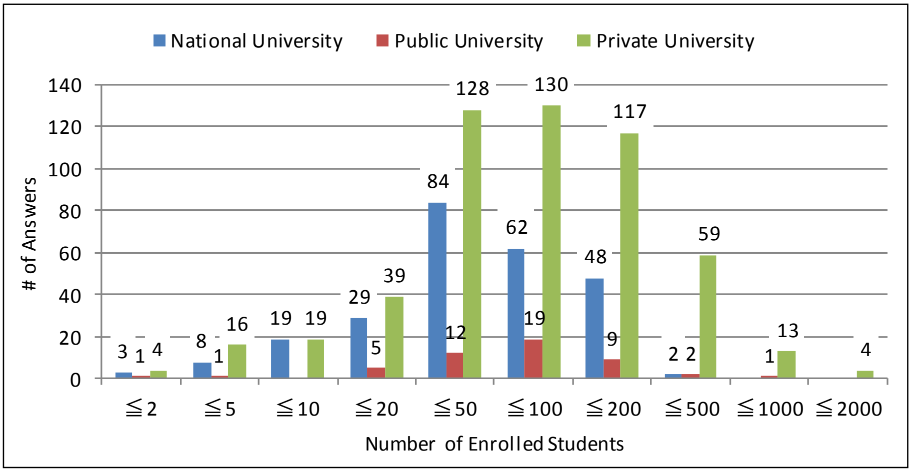

Fig. 16. Distribution of Student Enrollment.

numbers. For example, "≦20" means that the number is more than 10 and not more than 20.

The average number of enrolled students is 70.0 for national university, 87.3 for public university and 123.0 for private university. It can be observed that the number of enrolled students is larger at private university. In fact, 36.5 % of the private university has more than 100 enrollments.

6.2. *Number of Students per Teacher*

Fig. 17 represents the distribution of the number of students per teacher for the computing subject. The distribution greatly changes depending on the academic disciplines. The distribution is valuable to define accreditation criteria for the number of teachers for the computing subject. It will be reasonable to define the criteria at the lower 25% value of the distribution. If an educational program achieved better than the higher 25%, then it will be evaluated as a strong point of the program.

6.3. *Student's Choice of Career after Graduation*

Table 5 represents the student choice of career after graduation.

Since very small number of students go to graduate school majored in computing discipline, college level computing education ends at the undergraduate level. Although 13.8 % of the students go to a graduate school, the percentages greatly change at national and private universities.

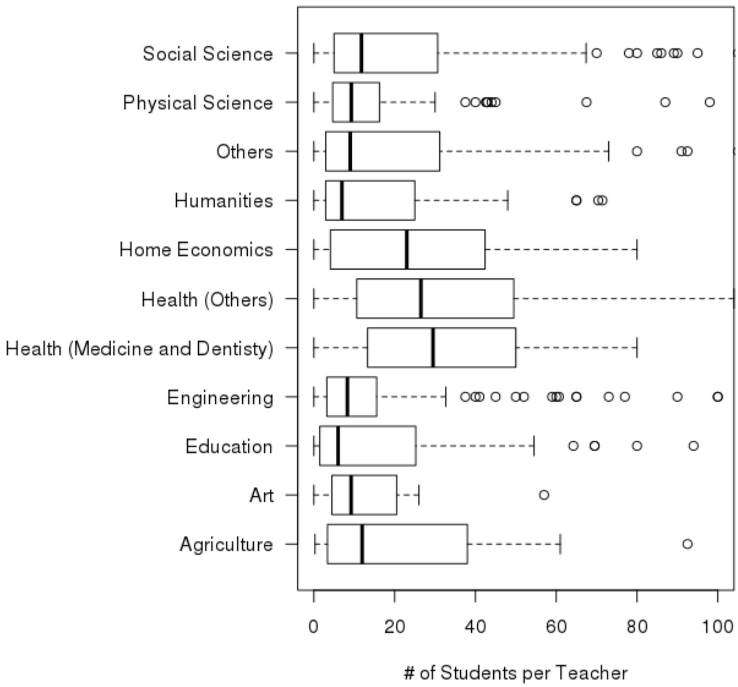

Fig. 17. Distribution of the Number of Students per Teacher.

Table 5
Student's Choice of Career after Graduation

University Type	Enter Graduate School		Get Job	Unknown
	Computing	Others		
National	443	9,270	15,969	2,498
Public	185	1,107	4,388	364
Private	147	4,757	66,911	9,603
Total	775	15,134	87,268	12,464

7. Teaching Staff

7.1. *Faculty Member*

Fig. 18 represents the number of faculty members teaching computing subject classified by the type of the faculty member and the university. The numbers shown in the bars represent the actual number of faculty members.

8,851 members are employed for specialized computing education. Full-time member ratio is higher at national and public universities. In fact, the ratio of part-time mem-

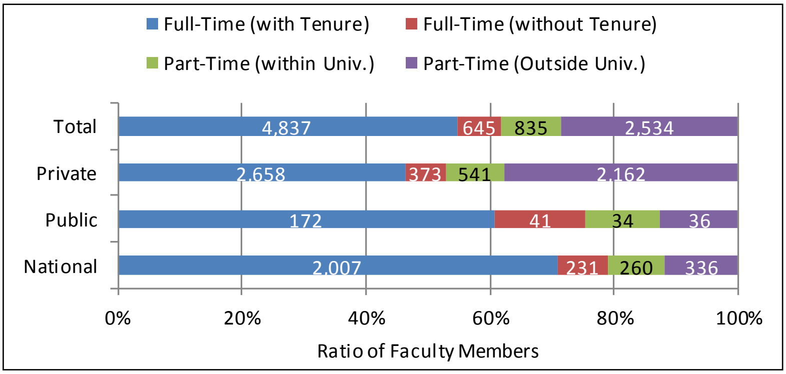

Fig. 18. Ratio of Faculty Members Teaching Computing Subject.

bers outside of the university is 37.7 % at private university. This is mainly because of the financial restriction and the restriction of full-time member post.

15,865 computing classes are held at each year. Full-time faculty members are in charge of more than 80% of the computing classes at national university as represented in Fig. 19. However, the ratio the part-time teachers outside of the university exceeds 25% at public and private university.

It is essential for the faculty members to have enough ability in the computing discipline to effectively teach students. We collected the number of computing department graduates and the number of faculty members whose current major is in the computing discipline. Fig. 20 represents the ratio of these two types of faculty members.

The ratio of computing department graduates is generally low in the four cases. The following is a list of the major reasons:

(1) The number of Ph.D. holders in computing discipline is far less than the required number of faculty members to teach computing subjects.

(2) Research contribution to the major field of the department is more important to hire a new full-time member than teaching ability of computing subject.

On the other hand, the ratio of faculty members majored in computing discipline is generally higher than the ratio of computing department graduates. This can be considered as an effect that the faculty member changed his/her major after getting position at the department and being assigned some computing subject.

7.2. *Support Staff and Teaching Assistant*

Table 6 represents the statistics of the support staff and teaching assistant (students to assist computing subjects).

It can be observed that teaching assistant is essential at many universities since the number of support staff is quite limited. Although most of the teaching assistants are the students of the employing university, students of the neighboring universities are also employed at a metropolitan area.

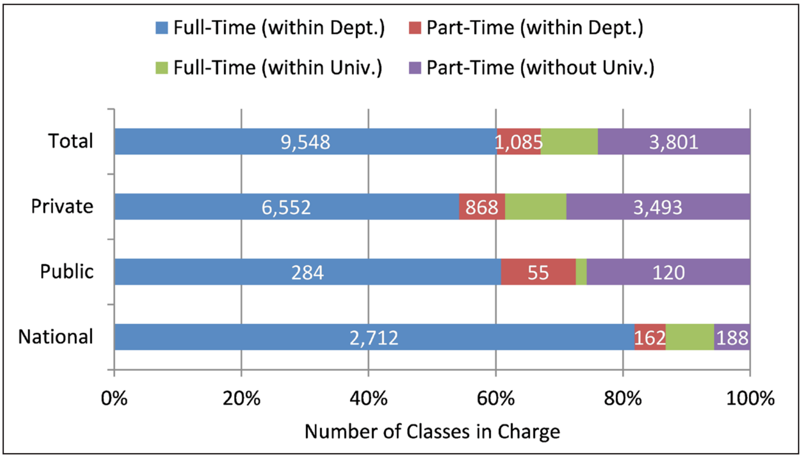

Fig. 19. Distribution of the Number of Computing Classes in Charge.

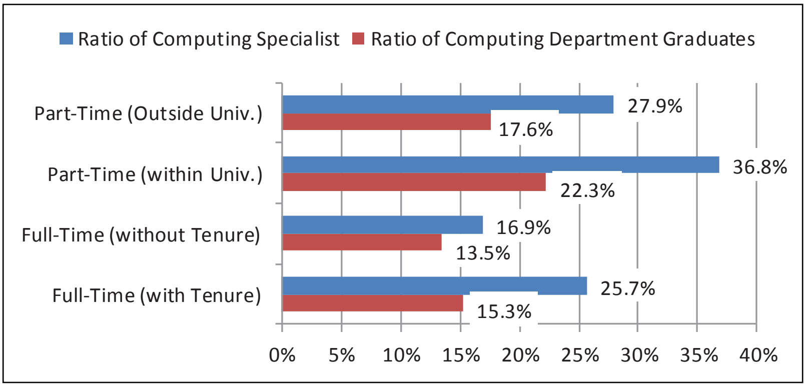

Fig. 20. Ratio of Computing Department Graduates and Faculty Members Majored in Computing Discipline.

Table 6
Support Staff and Teaching Assistant for Computing Subject

Univ. Type	Support Staff		Teaching Assistant	
	# of Staffs	# of Subjects	Workload (man hour)	# of subjects
National	166	74	42,390	818
Public	3	4	13,785	111
Private	434	432	73,125	1,889
Total	603	510	129,300	2,818

8. Computing Environment

8.1. *Educational Computer System and Student PC*

Educational computer system is important for effective computing education. Utilization of student PC for computing education is also important as the PC is getting cheaper. Table 7 and Table 8 respectively represent utilizations of educational computer system provided by the educational institution and the utilization of student PC.

We observe that 23.1% of the national universities do not have educational computer system in the university. This ratio is even larger in the cases of public universities (34.3 %) and private universities (37.6 %). 57.6 % of the universities utilize shared computer system.

80.6 % of the universities leave the decision to purchase PC to their students. Al though PC price is getting cheaper, it is still difficult for many universities to impose obligation to the students to purchase PC.

We also find that 28.4 % of the departments have no educational computer system and allow students to decide to purchase PC. We need further investigation to these departments. On the other hand, 7.0 % of the departments have educational computer system and require students to purchase PC. We expect that these departments provide effective computing education by utilizing the educational computer system and student PC.

Table 7
Utilization of Educational Computer System

Utilization	# of Answers	# of Enrolled Students
Shared Computer System at Unversity	356	38,148
Shared Computer System at Campus	141	12,839
Shared Computer System at Faculty	69	6,298
Private Computer System at Department	59	4,304
Computer System is provided but unused	43	4,201
No Educational Computer System	326	21,471
Total	994	87,261

Table 8
Utilization of Student PC

Utilization	# of Answers	# of Enrolled Students
All Students of the University must have PC	69	4,384
All Students of the Faculty must have PC	34	3,494
All Students of the Department/Course must have PC	26	2,335
Students are recommended to phrchase PC	65	4,744
Purchasing of Student’s own PC is optional	800	72,304
Total	994	87,261

Table 9
Popular Educational Programming Languages

Programming Language	National University	Public University	Private University	Total Score
C	174	38	254	466
Visual Basic/VBA	57	11	186	254
Java	40	4	102	146
C++	41	4	63	108
JavaScript	9	2	66	77
Fortran	34	2	27	63
SQL	8		23	31
Python	8		21	29
Ruby	6		19	25
PHP	6		16	22
R	13	4	3	20
Processing	3	3	9	15
Assembly Language	7		6	13
Matlab	7		4	11

8.2. *Educational Programming Language*

We collected three educational programming languages from each department with the highest achievement levels. Table 9 illustrates popular programming languages for the specialized computing education calculated using the collected data. The score of each language is evaluated as a weighted sum of the answers. The weight of a language is defined using the achievement level of the students at each department.

9. Concluding Remarks

We find that more than 100,000 students are learning computing subjects at non-IT departments or courses. The actual number of students would be even larger. Specialized computing education is carried out at all academic disciplines, which indicates importance of the computing education. We also find that the effort for the computing education is greatly different depending on the academic disciplines. The findings explained in Sections 4 and 5 will be useful to develop realistic curriculum guidelines for computing education at non-IT department or course. We also find shortage of teaching staffs specialized in the computing discipline.

Information Processing Society of Japan (IPSJ) published J17 curriculum standard for computing education in March 2018 (Information Processing Society of Japan, 2018). Since we find the importance of computing education at non-IT departments and courses through the survey, we intend to start a project to discuss about effective and feasible computing curriculum for non-IT departments and courses. We have a plan to collaborate with enthusiastic responders of this survey to develop effective project team.

Acknowledgment

This research is supported by JSPS KAKENHI Grant Numbers 16K01022 as well as by the Ministry of Education, Culture, Sports, Science and Technology, Japan. The authors greatly appreciate the faculty members and the administration officers of the universities who took time to respond to our survey.

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