National Institute of Informatics News ISSN 1883-1966 (Print) ISSN 1884-0817 (Online)

NII Today

73
Mar. 2020
National Institute of Informatics News

NII Interview

Challenges and Future Outlook of Talent Development in the Field of Information

Thoughts at the start of the JST GSC Experts in Information Science

Katsumi Emura [President, Information Processing Society of Japan & NEC Fellow]
Shuichi Sakamoto [Director for General Coordination to the Director General for Science, Technology and Innovation, Cabinet Office]
Masaru Kitsuregawa [Director General, National Institute of Informatics]

Senior High School Students Will Experience World-Class Research

Katsuhiko Kakehi [President, Japanese Committee for International Olympiad in Informatics]
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Nurturing Top Talent and Broadening Human Resources Base

Tetsuyuki Hongo [Director for Education, Headquarters Secretariat, National Institute of Technology]
Kentaro Noguchi [Counselor for Education, Headquarters Secretariat, National Institute of Technology]

Commentary

Curriculum of the JST GSC Experts in Information Science

Feature

Start of the JST GSC Experts in Information Science

Cultivating Young Talent in the Field of Informatics

This English language edition
NII Today corresponds to
No. 87 of the Japanese edition

Challenges and Future Outlook of Talent Development in the Field of Information

Thoughts at the start of the JST GSC Experts in Information Science

Katsumi Emura
President, Information Processing Society of Japan & NEC Fellow, NEC Corporation

Shuichi Sakamoto
Director for General Coordination to the Director General for Science, Technology and Innovation, Cabinet Office

Masaru Kitsuregawa
Director General, National Institute of Informatics

Interviewer: Kyoko Takita Deputy Managing Editor, Yomiuri Shimbun Tokyo Headquarters

Informatics is the foundation of modern society, and businesses applying informatics research results are driving the growth of the global economy. For Japan to have a global presence, the activities of young researchers who will be at the forefront of the next generation are vital. The question is how to find and cultivate world-leading young talent in the field of information. Katsumi Emura, NEC Fellow, President of the Information Processing Society of Japan; Shuichi Sakamoto, Director for General Coordination, Cabinet Office; and NII's Director General Masaru Kitsuregawa discussed the challenges and future outlook of talent development from the various perspectives of industry, government, and academia.

The thinking behind the name JST GSC Experts in Information Science

—— Japan's senior high school students achieve excellent results in the International Olympiad in Informatics (IOI) and the International Mathematical Olympiad (IMO). However, when they become university or graduate students, they are said to fall behind the world's top students. What do you consider to be the reason for this?

Sakamoto For students with outstanding ability, university studies can be not enough of a challenge. There are inadequacies in the environment as far as supporting a desire to accomplish something that exceeds people's imaginations. I think some students with excellent ability in informatics are going into other fields because they can't visualize what they would do if they cultivated that ability, causing outstanding talent to be lost to the field.

Emura In Japan's education system today, it is difficult for students to develop in the areas where their strengths are. Even if they put in excellent performances in programming and security contests, they move away from the areas where their strengths lie when they become busy with university entrance exams and such. Also, even if they have outstanding ability in a subject such as mathematics, their career options are narrowed if they aren't good at other subjects. A system for nurturing people with special ability and leading them to the top is needed, like in the worlds of *shogi, go,* and sports.

—— The JST GSC Experts in Information Science will start from fiscal year 2020. This is a new initiative to discover exceptional talent among junior and senior high school and technical college students and to cultivate world-leading researchers, isn't it?

Sakamoto It is a program in which students from the junior and senior high school level will receive guidance from leading researchers and will come into contact with cutting-edge research in the globally competitive field of information (see Commentary at the bottom of Page 9). When I was at my previous post as the Director of the Human Resources Policy Division at the Ministry of Education, Culture, Sports, Science and Technology, I considered the status quo in Japan, where the environment for cultivating outstanding talent is inadequate, to be a problem and investigated the design of this program by seeking advice from NII's Director General Masaru Kitsuregawa, Professor Ken-ichi Kawarabayashi, and other top-class researchers at institutions throughout Japan. Highly aware students think about their future at an early stage. If they can see the world of leading research, they will be able to get a sense of their future. We don't want them to get lost.

Kitsuregawa The information revolution is what underpins global economic growth. Over the past 50 or 60 years—a very short period of time—information and communications technology has greatly improved the productivity of society. The change has been rapid, and so clearly the human resources with the necessary skills are insufficient. Knowing that something must be done, NII mobilized

Masaru Kitsuregawa

all its capabilities to help implement this program. To be honest, I wanted the name to include information engineering, rather than being limited to information science. After all, in the field of information, science and engineering are 80% to 90% integrated and indivisible, so the word "informatics" would have been better.

Emura If we consider engineering to be on the side of solving things and science to be on the side of creating new things, I think that the name "information science expert" is fitting for nurturing people who will go on to create new things. Searching for where the next challenge lies, rather than researching methods that have already been defined, such as programming and deep learning—that exploration itself is information science.

—— Is there a question about whether informatics is science or engineering?

Sakamoto I think that informatics is science. Programming is not limited to systems whose structures are understood. Systems exist in the world whose structures are not immediately understood. Informatics has a role in figuring out those structures and revealing new worlds. One could say that an important role of science is to figure out systems, control them, and make it possible for them to be used in the development of society.

In materials science, for example, when a material is thought of as a system, the sequence is to figure out the phenomena occurring inside the material, formulate those phenomena, and create the tools for performing simulations. However, when scientific principles have been established to a certain extent, performing analyses within a scope that can be handled by those principles is not the same as figuring out complex matters in the real world that are not understood at all. Therefore, in the world of material science, the fundamentals based on existing scientific principles are separated from applications using real materials, and it is not really possible to solve real-life problems by researching the fundamentals. This is considered to be a problem.

I think that separating the fundamentals from real-life problems limits perspectives and causes silos to develop in the discipline.

Kitsuregawa In reality, IT is used in all areas, and there are many forms in which IT is combined with another discipline: for example, bioinformatics, and material informatics. If a discipline is siloed, I think it is because there are interesting problems there and so there are a certain number of researchers. In other words, I don't think that the development of silos itself is a problem.

Also, we can't sum up all of the subjects dealt with in informatics as systematization. Research on eliminating program bugs and theoretical research to reduce computational complexity, and so on, can be called pure science. However, in artificial intelligence (AI) at present, eliminating program bugs is realistically impossible, and it is necessary to explore what kind of program can actually be debugged. In other words, we can't get to the bottom of the problem without real-life problems. In that sense, from my point of view, the reality is that science and engineering are stuck together such that they are indistinct in informatics.

The significance of sending participants to research institutions overseas

—— Participants in this program will be sent to research institutions overseas, won't they?

Kitsuregawa Some people question whether it is necessary for students to go abroad in this Internet age, but my own experience was that going abroad changed my view of the world. Even if it is only for a short period, there is a lot to be gained from having that experience while young. Currently, the number of young people challenging themselves overseas is decreasing. That is true not just in the field of information, but studying in a country like the United States where information-related research results contribute greatly to economic growth has a great significance.

Platformers like GAFA (Google, Apple, Facebook, Amazon) dominate global business, but neither Uber nor Facebook have their own proprietary technology, rather they are skilled at using IT. Also, they take the risk of implementation despite technical immaturity. I want our young people to experience how the desire of startups that says "We want to create this kind of society" resonates with students in the United States and how they engage in it. It is quite difficult to learn about that in a Japanese corporation. I think that providing this kind of opportunity will be

Shuichi Sakamoto

Graduated from Kyoto University Graduate School in 1992 and joined the (former) Science and Technology Agency. Completed a master's program at the Massachusetts Institute of Technology. PhD in Energy Science (Kyoto University). At the Ministry of Education, Culture, Sports, Science and Technology, areas of responsibility included space stations, earth/environmental science and technology, nanotechnology/materials development, nuclear fusion, industry-academia collaboration, and cultivation of human resources in science and technology, before assuming the present post in July 2019.

Katsumi Emura

Completed a master's program at the School of Engineering, the University of Tokyo, in 1982, and joined NEC Corporation as an optical communications researcher. After experience in the Product Planning Division and working in senior management in the Intellectual Property Division, took up a post as Senior Vice President responsible for the Central Research Laboratories in 2010. Executive Vice President and CTO in 2019. NEC Fellow since June 2016. Visiting researcher at Bellcore in the United States from 1987 to 1988. PhD in Engineering (the University of Tokyo).

good for the future of Japan.

Emura When I talk to university students, few say that they want to work overseas in the future. Japan is safe, the food is delicious, and students can enjoy their own familiar subculture, so they are satisfied. But there is no guarantee that Japan will be as affluent in the future. That is why I want them to look outside of Japan. NEC Corporation has a "work abroad" program in which employees work for a fixed period at a nonprofit organization in India or another country. Some people have left the company to start venture companies in North America. Industry is implementing various initiatives, but that alone is not enough to keep up with the rest of the world. I think that the nurturing of human resources should be promoted through a variety of mechanisms including the JST GSC Experts in Information Science.

Sakamoto Although they may be content in affluent Japan, some young people are searching for what they want to do. Some people do have a keen interest in how they can make the most of their own abilities. I want to encourage them and make them realize that they can do amazing things if they develop their abilities.

How is talent developed in the field of information?

—— Is there a methodology for developing talented people in information?

Emura I think that education received from other people and learning by oneself should come as a set. For example, rather than remembering programming methods as knowledge, people should learn that when a certain problem arises it can be solved using a particular programming method. This is the "just-in-time learning" approach. Students are taught various things at university, but they don't know what kind of situation they should use that knowledge in. Sometimes they don't understand the meaning of what they have been taught until they start working for a company.

Sakamoto Olin College of Engineering in the United States is known for its hands-on manufacturing education. During the 1990s, the best students in engineering departments often went on to other fields such as finance. As a response to this, Olin College of Engineering, a newer university, was founded with the intention of returning to the origin of engineering—the joy of making things—and its education is highly regarded. Students think for themselves about what they want to make and what knowledge they need for that. It is entrepreneurship education that leads to starting businesses. In classes, instead of providing knowledge, the faculty members teach the students how to acquire knowledge. Lectures account for one-third of classes, while the remainder are project-type classes in which students experience making things.

In Japan too, technical colleges are structured so that the talents of students are developed from an early stage, and technical college graduates are in great demand by companies. Also, the main aim of Super Science High Schools (SSH) is to motivate students towards the world of science and technology, although in reality there can be difficulties balancing this with students going on to university.

At the Ministry of Education, Culture, Sports, Science and Technology, I was engaged in the SSH project. I had discussions with experts in the field of education, and I thought about certain hypotheses in policy terms. The cognitive domain of accumulating and using knowledge, including studying for university entrance exams, and the non-cognitive domain of the desire to do something and self-confidence grow by stimulating each other. It is because students have knowledge learned from textbooks that they are able to think about what they want to do. However, when they only strengthen their cognitive abilities, they miss the chance to fully develop their non-cognitive abilities. They seem to lose their sense of what they want to do. That is why "just-in-time" is important. Stimulation appropriate to the developmental stage is thought to be beneficial in terms of nurturing talent. Of course, when and what kind of stimulation will cause buds of talent to emerge and grow differs depending on the individual, so this is not an easy problem to solve. However, encouraging the development of cognitive and non-cognitive abilities in a cascading manner is important when nurturing scientists and innovators.

It is extremely difficult to determine the future ability of an individual child at a certain point in time. But there is a fixed probability that outstanding talent exists, and therefore after expanding the base, I think it will be possible to provide education that increases, even if only a little, the probability of finding people with outstanding talent and developing their talent.

Kitsuregawa We're talking about complete educational reform. How about putting this kind of development method into practice with the JST GSC Experts in Information Science participants? I am looking forward to seeing how the program participants and winners of the Olympiad in Informatics have developed when they are followed up in five or ten years.

Young people have diverse talents, and it would be great if a system could be created to successfully develop those talents. We don't know when or how talent develops. That's why a methodology is difficult. I don't particularly like the idea of teaching entrepreneurship to young undergraduates. It may be one component, but not everyone has to create a company like Uber.

The fundamentals are the most important thing. If students have the fundamentals, they can do any job in the future. Students of the University of Tokyo, in particular, use huge amounts of taxpayer money. I think that they should learn the fundamentals. To me, the "just-in-time learning" approach means giving students undergraduate thesis or master's thesis tasks that incorporate the critical thinking skills that they have. When that is done, they develop remarkably. There are no limits as far as the abilities of students are concerned. The most important thing for university teaching staff is to avoid inhibiting those abilities. I was told by a senior colleague at the University of Tokyo to treat my students based on the assumption that they are smarter than me, and I always keep that in mind.

Expectations regarding top talent, and the role of government and business

—— The JST GSC Experts in Information Science is recruiting some exceptional talent, but will that change informatics

research and industry in Japan?

Sakamoto People who are exceptional in terms of both talent and motivation have confidence and can express their vision. If innovators who say, "I want to change the world like this," appear, a team forms around them, and social change occurs. I think that this kind of flow needs to be created in the field of information science first. I mentioned entrepreneurship education because it is valuable not only for launching startups but also in terms of changing scholarship and society.

Emura From an industry perspective, there aren't enough outstanding people who will initiate change, but there also aren't enough engineers or data scientists. We need to secure millions of people and raise their skill level as well. Like how people living in farming villages became workers in cities during the Industrial Revolution, people's jobs have changed irrevocably with the advent of computers in the information revolution. Everyone must become information literate as a matter of course, acquiring the basic skills at elementary and junior high school. Not only do they need to know programming languages, but they also need the ability to think logically.

Japanese companies are offering generous employment packages to exceptional talent. However, it's not just an issue of employment conditions. There is also a need for communication on both sides, with the company showing the employee what they could do if they worked for them and the employee telling the company how they might use their abilities.

Internships are one example of this. Internships in the United States are long, between two and three months, and the students do tasks that the researchers are too busy to do. In Japan, however, few companies accept interns for lengthy periods, and long internships are difficult for students too because they have job hunting, school assignments, and so on. Now, the JST GSC Experts in Information Science has been created as a kind of gateway, but to continually develop talented human resources, we must consider the second step and the third step.

—— A shortage of human resources in the field of information is frequently pointed out in industry. What is causing a bottleneck?

Kitsuregawa The pace of change is too fast. While human resources are being developed, the next technology appears. Technology becomes old in about three years. Successful companies such as Google have good in-house training. Both companies and employees need to be considered, but shortfalls in human resources or shortages of posts in specific fields are due to the structure of Japanese universities being way too inflexible. In contrast, Stanford University's AI class is attended by 3,000 students.

Emura The problem of human resources is a serious concern for companies. There is a sense of speed such that before you know it, the technology required by a business has changed. People must acquire the skills to handle a new job through recurrent education, but this can't be done in a short period of time. This means that many people are doing jobs that may be replaced. Alternative initiatives must be pursued, including our approach to employment.

Building an ecosystem with NII and the Information Processing Society of Japan at its core

—— How are NII and the Information Processing Society of Japan addressing the development of young talent?

Kitsuregawa NII supports the International Olympiad in Informatics [1]. We also support various national projects in many ways, such as the Ministry of Economy, Trade and Industry's MITOU Program to discover IT "Super Creators."

When I was President of the Information Processing Society of Japan, we created a Junior Membership Program. Membership is free for students from elementary school until their third year of university, and they can read the IPSJ magazine and attend research events. The number of elementary and junior high school student members is increasing.

Emura I want to connect junior and senior members. We are in the era of the "100-year life," and so we need opportunities to use our skills even after retirement. I think it would be good if senior members who have a wealth of life experience could mentor junior members, and if we could create opportunities for interaction between senior and junior members at conferences, for example. We are also providing opportunities for participants in the JST GSC Experts in Information Science to give presentations at conferences.

Sakamoto I think that NII will become a core where the will of people who want to change society through information science and technology will resonate. I hope that conferences make an overall effort to create the system for this resonance. And I hope that we can build a human resources ecosystem in which students with a desire to do something will attend conferences, discover an image of their future self, and aim to be a leading researcher.

(Photography by Tadashi Aizawa)

Note

[1] NII provided the SINET5 network, developed and operated by NII, at the 30th International Olympiad in Informatics (IOI 2018 Japan) held in Tsukuba, Ibaraki Prefecture, in 2018. A dedicated virtual private network (L2VPN) was constructed to connect the competition venue to the Tokyo server.

A Word from the Interviewer

A national convention celebrating the 60th anniversary of the founding of the Information Processing Society of Japan, due to be held after this three-way conversation in March, was hosted online as COVID-19 infections spread. The junior and senior high school student divisions were also held online. Not only were conferences held virtually, but many companies introduced remote working, and society was supported during this state of emergency by the robustness of our information and telecommunications infrastructure. In information science and engineering, economic growth and providing a source of wealth in a new era tend to be emphasized, but I think that more should be made of the problem-solving capabilities that are used to maintain social functions during pandemics and natural disasters. I am sure that there are talented young people who share that view.

Kyoko Takita

Deputy Managing Editor, Yomiuri Shimbun Tokyo Headquarters
In 1989, graduated from the Faculty of Foreign Studies, Sophia University, and joined the Yomiuri Shimbun. In 2000, graduated from the Graduate School of Journalism, University of California, Berkeley. From 2002, responsible for science and technology policies, IT, space exploration, environment, disasters, etc., in the Science News Department. After serving as Editorial Writer and Science News Department Editor, assumed her current role in 2018.

Senior High School Students Will Experience World-Class Research

Early discovery and development of talent through public-private sector collaboration

Katsuhiko Kakehi
President, Japanese Committee for International Olympiad in Informatics; Professor, Faculty of Information and Management, Tokyo Online University

Ken-ichi Kawarabayashi
Deputy Director General, National Institute of Informatics; Professor, Principles of Informatics Research Division, National Institute of Informatics; Professor, School of Multidisciplinary Sciences, The Graduate University for Advanced Studies

Interviewer: Jun-ichi Taki Senior Staff Writer, Editorial Bureau, Nikkei Inc.

The JST GSC Experts in Information Science, aimed at finding and nurturing young talent who can flourish in the world of information science, is about to make a full-fledged start. In this program, junior and senior high school and technical college students who are interested in mathematics and algorithms and excel at programming will have the opportunity to come into contact with world-leading research and conduct joint research with young researchers. National Institute of Informatics (NII)'s Deputy Director General Ken-ichi Kawarabayashi, responsible for planning and operating the program, and Katsuhiko Kakehi, President of the Japanese Committee for International Olympiad in Informatics, who is helping to find talent, discussed topics including the awareness of issues behind the program.

Starting information science research from a young age

Taki What does the JST GSC Experts in Information Science consist of?

Kawarabayashi To put it briefly, it is a program aimed at raising excellent young talent in Japan who will be able to rank alongside scientists and engineers at the IT giants represented by GAFA (Google, Apple, Facebook, Amazon). Japan's junior and senior high school and technical college students perform on a par with the world's best at international contests such as the International Olympiad in Informatics (IOI) and International Mathematical Olympiad (IMO). However, it appears that those students often fall behind the world's best by the time they finish their doctoral courses.

This is because they don't come into contact with world-leading information science research or gain experience in conducting and presenting their own research until it is too late. The main brains behind GAFA are between 30 and 35 years old, but in Japan, students get their doctoral degree between the ages of 27 and 28 and then embark on their careers as researchers. That is too late. They can't keep up with the world's top researchers unless they have had the experience of presenting a good paper by the age of about 25 and experience hardships. Places where informatics research is being conducted and the government, including the Ministry of Education, Culture, Sports, Science and Technology, share a sense of crisis that Japan's students are missing the boat in the existing education system.

Taki So, this program tries to make talented young people aware of the appeal of information science from the first year of senior high school?

Kawarabayashi It is impossible to modify Japan's education system for the sake of information science. Instead, we are recruiting about 30 participants, mainly targeting students in the first and second years of senior high school. In the first phase of the development process (see Commentary at the bottom of Page 9), participants will gain wide knowledge about information science at university laboratories in Japan. In the second phase, they will actually participate in research being carried out at the labs. This will be joint research with top researchers.

The participants will go to the labs after school or on Saturdays, but they will also be able to take part from their homes via the Science Information Network (SINET developed and operated by NII). During this time, young researchers in the field of information science will become mentors to the participants and will provide consultation and advice. Students in the third year of senior high school have university entrance exams and the like, so they will temporarily "graduate" from the program. However, if they wish, their mentor will continue to follow up with them after they have gone on to university. We are also considering providing study abroad opportunities for program participants who have developed a track record such as presenting papers.

Taki It seems like the program brings forward the kind of research that is usually experienced between the second half of an undergraduate course and graduate school by about five years.

Katsuhiko Kakehi

In 1970, completed a Master of Engineering program at the School of Engineering, the University of Tokyo. Master's in Engineering. Served as an associate at the Faculty of Engineering, the University of Tokyo; assistant professor at Rikkyo University College of Science; and as a professor at the Faculty of Science and Engineering at Waseda University. Currently, professor at the Faculty of Information and Management, Tokyo Online University, and professor emeritus at Waseda University. Also serves as chair of the Japan board of the Association for Computing Machinery's International Collegiate Programming Contest (ACM-ICPC); chair of the Programming Contest committee in the PC Koshien, chair of the review committee of the U-22 Programming Contest; president of the Japanese Committee for International Olympiad in Informatics (NPO); and chairman of the International Information Science Foundation.

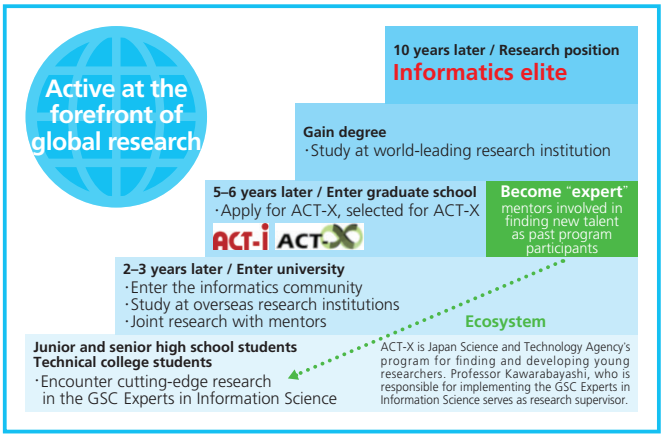


Figure1 Vision of the future of the JST GSC Experts in Information Science and creation of an ecosystem. Proceeding with a 10-year plan.

Selected from students with experience of the Olympiad in Informatics, technical college students, etc.

Taki Is there world-class talent in Japan?

Kakehi That is clear from Japan's achievements at the International Olympiad in Informatics. We send four representatives each year, and they all earn medals. Our best performance was at the Iran contest in 2017, when three representatives took gold medals and one took silver. The students try to come up with an algorithm that solves a given problem, write a program based on that algorithm, and actually run the program on a computer, and they compete over how quickly and accurately they can obtain the solution. Gold medals are awarded to the top one-twelfth of participants.

More than 1,000 people apply to be selected as a Japanese representative each year. About 20 of them remain at the final screening, and those students can be said to be at a world-class level. Many are students in prestigious college preparatory schools, such as Nada High School and Kaisei Senior High School, and there are a few junior high school students. At these schools, some senior students have already won medals at the International Science Olympiad and so the mental barrier to participation is low.

Considering that there are also students with potential talent that will grow if stretched at schools other than college prep schools, we are endeavoring to widen the recruitment scope. In fact, there was a student who applied from a public junior high school. The student wasn't selected initially, but after studying and entering senior high school, the student became a Japanese representative at an international contest. I am sure that more students like that will be discovered if the gate is widened.

Taki The Japanese Committee for International Olympiad in Informatics will nominate motivated students from among those selected for the Olympiad to participate in the JST GSC Experts in Information Science, won't they? And the program will start fully in fiscal year 2020, after recruiting about 30 people this year (fiscal year 2019).

Kawarabayashi From junior and senior high school and technical college students throughout Japan, just over 30 students will be selected through public recruitment via NII and the Information Processing Society of Japan, as well as nominations by the Japanese Committee for International Olympiad in Informatics. Depending on where the participants live, the university laboratories they will visit will be chosen with the help of regional branches of the Information Processing Society of Japan. Students from regions other than Tokyo and Osaka are very welcome. There will be no tuition fees, and some travel expenses will also be covered.

The program is currently scheduled to run for three years (three batches of recruitment), but I think that it must continue for at least ten years. The "experts" who have gone on to university after the program and built a track record will in turn become mentors and will coach the junior and senior high school students. By building this kind of ecosystem, the range of scientists and technicians in information science can be expected to widen and the pool of talent to steadily grow.

A Word from the Interviewer

When young people doing exceptional things, such as starting IT venture companies, were asked when they first developed their programming skills in a major way, most of them replied that it was in the second year of junior high school. It appears that talent in information science and mathematics emerges in the mid-teens.

Programming education introduced in elementary and secondary education is expected to broadly improve average literacy in information science, but care should be taken so that precocious talent is not nipped in the bud.

Jun-ichi Taki

Senior Staff Writer, NIKKEI INC.
Born in 1956. After graduating from the School of Political Science and Economics at Waseda University, joined Nikkei, Inc. After working in branch offices and covering corporate news, began covering science and technology, as well as environmental fields, starting from the mid1980s. Authored "*Eco-Uma ni Nore!*" (Shogakukan) and co-authored "*Kansensho Retto*" (NIKKEI,Inc.), among others.

The significance of an elite education

Kawarabayashi In soccer, the number of players who can star in the World Cup is limited. The opportunity to develop by competing with the best in the world from an early age is vital. I want to raise young people like soccer player Takefusa Kubo who transferred to Spain's Real Madrid at the age of 18.

Taki Which means an elite education in information science?

Kawarabayashi The important thing is the extent to which a person can develop their strengths by coming into contact with the top level early in life. A broad education covering disciplines other than information science is also necessary, but that study can be done at an unhurried pace appropriate to the age of the student. The idea of everyone improving at an average pace is firmly rooted in Japan, but that makes it impossible to cultivate human resources with exceptional talent.

Kakehi The student from a public junior high school who was mentioned earlier developed abilities through special treatment, as it were, such as participating in a selection camp for the Olympiad in Informatics. The student was inspired by students from college prep schools attending the same camp, as well as tutors and university faculty, and was able to develop abilities by reading university textbooks borrowed from the library and solving practice problems on their own and enjoy doing that at the same time.

Kawarabayashi Putting aside rivalry with GAFA, I think that increasing the number of talented people researching the fundamentals of information science is important for the future of the world.

(Photography by Takuya Furusue)

Ken-ichi Kawarabayashi

Nurturing Top Talent and Broadening Human Resources Base

The challenge for technical colleges expected to shine in the field of information

Tetsuyuki Hongo
Professor and Director for Education, Headquarters Secretariat, National Institute of Technology

Kentaro Noguchi
Professor and Counselor for Education, Headquarters Secretariat, National Institute of Technology

Interviewer: **Atsuko Tsuji**
Designated Professor, International Collaboration Planning Center, Institute of International Education and Exchange, Nagoya University

Technical colleges are known for developing many capable people who are highly regarded as practical technicians, and they are also a source of talent in the field of information. The JST GSC Experts in Information Science is targeted not only at junior and senior high school students, but also students from technical colleges. Technical colleges educate all students in information literacy from an early stage, but they are also aiming to develop top talent in information and will actively encourage students to participate in the JST GSC Experts in Information Science. However, there are challenges. I spoke to Tetsuyuki Hongo, Director for Education at the National Institute of Technology, and Kentaro Noguchi, Counselor for Education at the National Institute of Technology, who specializes in information.

Technical colleges earning high acclaim with unique curriculum

Tsuji Technical colleges are well regarded, not only domestically but internationally too, as higher education institutions that train technicians.

Hongo Technical colleges were established in 1962 with the aim of training mid-level technicians through five-year integrated education from the age of 15 to 20. Subsequently, in response to the advancement of technology, advanced courses that allow students to earn a degree in five years plus an additional two years were established. In 2004, national technical colleges were organized into an independent administrative institution called the National Institute of Technology [1]. The current objective is to develop practical technicians, in other words, nurturing technicians with engineering design abilities who can discover and solve problems themselves. Emphasis is also placed on human skills and the ability to continue learning even after graduation. The percentage differs between technical colleges, but taking colleges belonging to the National Institute of Technology (hereafter, "national technical colleges") as a whole, approximately 60% of graduates enter employment and many work in leadership roles. The remaining 40% or so either continue to an advanced course that will allow them to enter graduate school or transfer to a university undergraduate course. Many of those who transfer to an undergraduate course also go on to graduate school [2].

Tsuji What is the education like in the field of information?

Hongo At national technical colleges, students in electrical and electronics courses, information courses, and so on—or IT personnel in the making, as it were—account for about 45%. However, as well as education in each specialty based on a model core curriculum, all students acquire a minimum level of information literacy —particularly security knowledge—as an interdisciplinary skill. Whether they are doing mechanical, civil engineering or chemistry courses, students gain an understanding of what should be protected in each field.

Noguchi In the information field, human resources are lacking in terms of both quality and quantity. Learning while young is more effective, so technical colleges have an important role. As an example, colleges are working to develop talent in the field of cybersecurity, and in 2017, a team from Kisarazu College entered and won the intercollegiate Crisis Management Contest. There are definitely top-class students in technical colleges, and they are performing well. There are also graduates who are doing remarkable work in the field of information.

Producing top talent in information with a unique approach

Tsuji How will technical colleges engage with the JST GSC Experts in Information Science?

Hongo To the extent that they don't have university entrance exams, technical college students are in an environment that is conducive to taking part in the program, and we want to make

Tetsuyuki Hongo

Graduated from Toyama College in 1982. Completed a master's program at Kanazawa University in 1986 and a PhD (engineering) in 2000. Joined Nachi-Fujikoshi Corporation in 1986. Became an assistant at Toyama College in 1988 and a professor at Toyama College in 2003. Became professor at Headquarters Secretariat, National Institute of Technology in 2015.

Kentaro Noguchi

Graduated from Kumamoto Denpa Technical College (now, Kumamoto College) in 1994. Completed a doctoral course at Toyohashi University of Technology in 2001. PhD (engineering). After serving as an assistant at said university, became an associate professor at Okinawa College in 2005 and an associate professor at Tokyo College, before taking up his current position. Specialties are digital signal processing and welfare engineering.

full use of the program as a new learning opportunity. After all, the aim of technical colleges is not only to train technicians but also to produce professionals for the need for diverse human resources. I have high hopes for this program as a way of cultivating top human resources. I'm really looking forward to seeing what kind of professionals result from participating in the program and what kind of impact the students who participate have on those around them. I also think that having the students appear in this kind of arena will be an opportunity to understand the strengths and weaknesses of technical colleges.

Noguchi For teaching staff, I think that the program will be an opportunity to keep abreast of movements in the rapidly changing information field and to learn about society. Therefore, we would like to apply the knowledge gained to the curriculum. For that reason, we'd really like feedback on what students learned and what changes there were when they met their mentors in this program. Outcomes are important so that it doesn't end up as just an event, but it is essential to visualize learning. It's not only in this regard, but everyone has his/her own role, so it is important that the baton be passed properly in terms of what students have become able to do.

Tsuji Are there any challenges?

Hongo National technical colleges were originally established as regional pillars, so they are not in prefectural capitals but in places without a university engineering department. Thus, there is the issue of whether students can get to the university where their mentor is. In an information course, people can interact remotely using IT, so perhaps it will be possible to turn the inconvenience around and create a new learning model. It would be interesting if a new learning model could be created, and we would certainly want to make use of it.

Noguchi When it comes to truly top talent, there may not be many in the entire country, but they are definitely somewhere. It is important that they are given the opportunity to learn. Their talent is sure to grow if given the chance. As in the example of Kisarazu College mentioned earlier, talent develops rapidly if only students have the opportunity to challenge themselves freely and safely.

Hongo Yes, sometimes to the extent that teaching staff can't keep up. Also, a characteristic of technical colleges is that if one student leaps ahead, everyone continues together, so it will be interesting when the students who participate in the program come back. Young people teaching each other, for example, people teaching at their old college or graduates who have started businesses coming back to teach younger students, is mutually beneficial. This kind of virtuous cycle, or ecosystem, exists at technical colleges anyway. It is one of our great strengths, and I think that it could contribute to the sustainable development of this program.

Hopes for various collaborations between students and between teaching staff

Tsuji What do you expect from NII?

Hongo Technical colleges place great importance on links with local companies as exit options, as well as on links with universities and large corporations in terms of advanced research. By having a face-to-face relationship with NII, we will be able to create various links in areas such as intellectual property education, speaking in terms of my own specialty. If collaborations form between technical college students and students coming to NII from abroad, some interesting global chemical reactions could happen. I expect that increasing interaction between teaching staff will also reveal new career paths to the students.

Noguchi Technical colleges tend to be closed worlds, so diversity is of utmost importance. I would like the JST GSC Experts in Information Science to show students various paths and provide a new stimulus in higher education. The success of the program will depend on how the students transform. (Photography by Tadashi Aizawa)

Notes

[1] There are a total of 57 national, public, and private technical colleges (51 national, 3 public, and 3 private) in Japan, and approximately 60,000 students in total.
[2] In 2018, of 9,006 graduates, 5,290 immediately entered employment and 3,501 went on to further education (of which, 1,475 went on to an advanced course and 2,023 transferred to university). Also, in the same year, 1,497 students completed an advanced course, and of those, 940 next entered employment and 529 went to a graduate school at a national, public, or private university.

A Word from the Interviewer

Only a few, one in a hundred students who graduate from junior high school, go on to a technical college. However, with technical college graduates accounting for one in ten technicians and one in five staff working overseas, it appears that the visibility of technical college graduates is increasing. Professor Hongo expressed a strong desire to link every opportunity to learning, saying, "Technical colleges are regarded more highly than people imagine, and we are working hard to make sure they live up to that." In that sense, expectations are high for the JST GSC Experts in Information Science. I hope that it will be a springboard to further success for technical colleges.

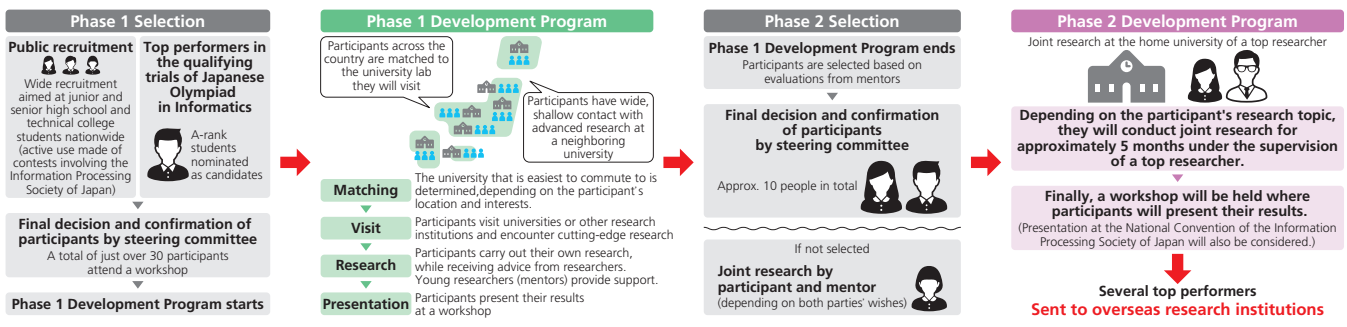
Atsuko Tsuji

Designated Professor, International Collaboration Planning Center, Institute of International Education and Exchange, Nagoya University. Graduated from the Department of History and Philosophy of Science, College of Arts and Sciences, the University of Tokyo, in 1976. Joined the Asahi Shimbun in 1979 and was primarily responsible for writing on science, technology, and medicine in various posts including in the Science Department, the American General Bureau, and as an editorial writer. Took up her present post in October 2016. Writes a column titled "Meidai Watch" on the Nagoya University website.

Commentary

Curriculum of the GSC Experts in Information Science

After the Phase 1 and Phase 2 development programs, exceptionally talented students are given the opportunity to conduct research at a prestigious university overseas. Implementing organization: NII; Collaborating organizations: Information Processing Society of Japan, Japanese Committee for International Olympiad in Informatics



NEWS 1

What is topological photonics?

Professor Satoshi Iwamoto, the University of Tokyo, gives 4th Public Lecture "The Forefront of Informatics"

The National Institute of Informatics 4th Public Lecture "The Forefront of Informatics" was held on January 21. Professor Satoshi Iwamoto (Research Center for Advanced Science and Technology, the University of Tokyo; Research Member, Science of Hybrid Quantum Systems in Scientific Research on Innovative Areas) was invited to give this final lecture in 2019. His lecture was titled "Manipulating Light Using Topology: Does Light Distinguish between Balls and Donuts?" (see photograph).

Optics and photonics technologies are used in familiar devices and are indispensable in our daily lives. Attracting attention as a new development in this area is the field of "topological photonics," which attempts to control and use light by introducing the mathematical concept of topology. Topology is a branch of mathematics that roughly classifies the shapes of objects so that objects that become the same under continuous deformation are considered to be the same shape. This topological approach can be also be applied to things other than visible objects, such as networks.

In light in a periodic structure, there is a relationship between direction (more accurately, wavenumber) and energy (band structure). Band topology considers the topology of shapes described by wave functions and light distribution when circling along bands in wavenumber space. When the band topology connects to a different object, a special condition called an "edge state" occurs. Light discerns where the band topology switches and comes to exist in an edge state. In other words, light does distinguish between balls and donuts.

By applying this concept of band topology to light in periodic structures such as photonic crystals, researchers are trying to develop and apply new functions. This new field is called topological photonics. Professor Iwamoto said, "New optics technologies using the three components of mathematics (topology), physics (physical properties), and engineering (photonic nanostructure technologies) are on the way. I want you to know that a new field with this kind of potential is picking up steam."

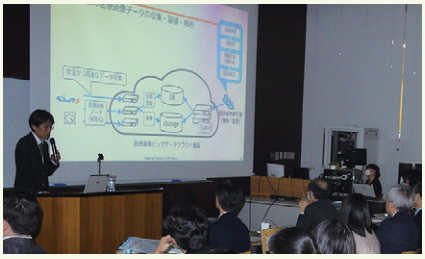
NEWS 2

Introducing efforts for new support for medical care using IT

Professor Aida speaks at ROIS Symposium

The Research Organization of Information and Systems (ROIS), which is composed of institutes such as NII, held the ROIS Symposium 2019 on February 7 at the Bunkyo School Building on the University of Tsukuba Tokyo Campus. The title of the symposium was "Data Science: Unlocking the Mysteries of Life, the Earth, and the Universe, and Tackling Issues of Humanity and Society," and various research results related to data science were presented.

From NII, Professor Kento Aida, Information Systems Architecture Science Research Division, gave a lecture titled "New Support for Medical Care Using IT: Big Data Cloud Platform for Medical Imaging" (see photograph). NII established the Research Center for Medical Big Data in 2017 and is working on building a shared platform for collecting, storing, and analyzing large volumes of medical images via the Science Information Network SINET5 (Big Data Cloud Platform for Medical Imaging) and developing AI-based medical image analysis technology. Professor Aida introduced the latest research results and gave the example of AI-based diagnostic imaging for



which demonstration experiments have begun in Fukushima Prefecture. He said, "We will continue to fine-tune the system, while incorporating opinions from the fields of both medicine and informatics."

NEWS 3

Helping to create online hosting environment for DEIM2020

563 researchers and students participated remotely using IT

NII helped to create the online hosting environment for the 12th Forum on Data Engineering and Information Management/ 18th Annual Meeting of The Database Society of Japan (hereafter, DEIM2020), held from March 2 to 4.

In all, 73 oral presentation sessions and two interactive sessions were held over the three days, with ten sessions running concurrently in the same time slot. The progress of the DEIM Forum was monitored at NII's main offices, where a technical support center was set up to facilitate the online proceedings, a venue for invited speakers to give talks was provided, and many large-screen displays were installed. Session participants used Cisco Webex Meetings® (Cisco Systems, G.K.) to join the online sessions from their respective locations, whether at home, work, or in a research lab. With a session chair, presenter, and audience, each session featured a presentation and Q&A session. Talks by invited speakers, which attracted large audiences, were broadcast on YouTube Live and LINE LIVE, with the cooperation of LINE Corporation. A joint team from the DEIM 2020 Executive Committee and NII developed and piloted an online participant dynamics monitoring system, and successfully visualized the dynamics of the conference participants in real time.

DEIM 2020 was one of the first academic conferences to be hosted online, and it open-sourced its initiatives and accumulated expertise, including providing information to the organizers of the 82nd National Convention of the Information Processing Society of Japan (IPSJ), which was held virtually from March 5 to 7. NII assisted these efforts by developing a batch registration function for online conference systems, as well as session automatic controls and session log monitoring, using the Webex Meetings API.

DEIM 2020 Online Conference Office

NEWS 4

Developing a method for automatically analyzing the safety of automotive system designs

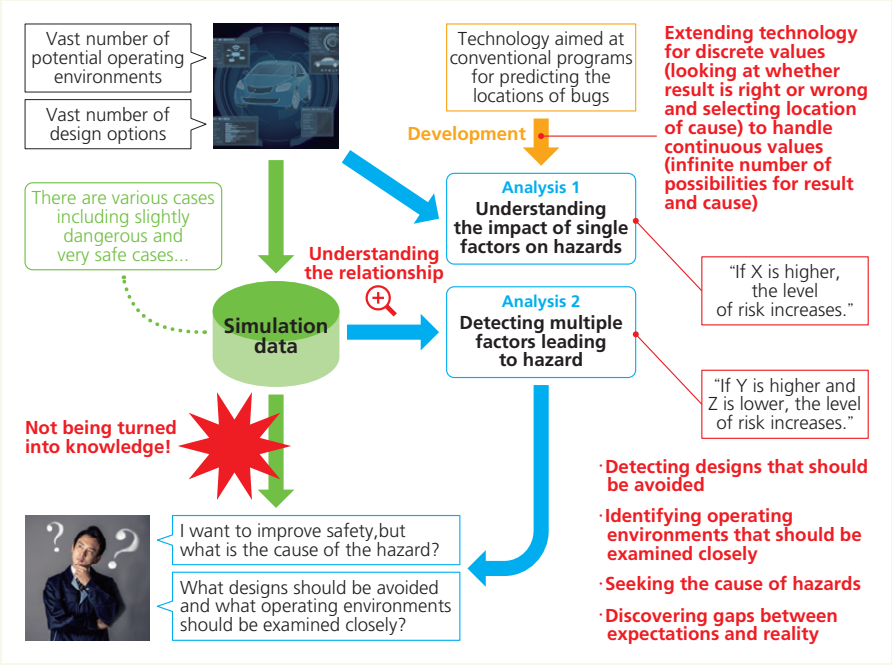
Extracting and organizing risk factors from diverse design and operating environment data as knowledge

The research team of Associate Professor Fuyuki Ishikawa, Information Systems Architecture Science Research Division, has developed a method for automatically analyzing the safety of automotive system designs[1].

As autonomous driving develops, when analyzing the safety of automotive systems, it is essential to evaluate what impact the vast numbers of design options and potential operating environments will have on safety. However, because there are countless combinations of the two types of parameters that have a major influence on behavior (design parameters: horsepower, brake force, etc.; environmental parameters: dry road surface, slippery road surface, etc.), it is difficult to extract and apply knowledge from the data, even if numerous simulations are run.

Therefore, the research team developed a method of automatically analyzing the relationship between the design and environmental parameters and the safety of the overall system. This method comprises two stages: analyzing how much each parameter influences safety by itself and analyzing how the interaction of parameters influences safety. When the method was applied to simulation data, the results showed that it can identify the important parameters relating to potential hazards and the patterns of interaction of parameters.

These research results earned the Best Paper Award at the International Conference on Engineering of Complex Computer Systems, ICECCS 2019.



Schematic diagram of the developed method for automatically analyzing the safety of automotive system designs

[1] This research was implemented by the ERATO Metamathematics for Systems Design Project with the support of the Japan Science and Technology Agency (JST)'s Strategic Basic Research Program (ERATO) (JPMJER1603). Also, it was implemented based on a physical control model provided by Mazda Motor Corporation. (The model invented in this research is a prototype for use in research evaluations, and its quality has no relation to the quality of the final product.)

NEWS 5

Publication of new edition in Jouhouken Series, *The Learning Compass*

A simple introduction to learning analytics

NII released Jouhouken Series No. 23 (Maruzen Library) *The Learning Compass: Learning Analytics*[1] on January 28 (see photograph).

Learning analytics is a field of research that objectively analyzes questions such as what is currently happening in education and learning settings and what factors could make the difference between success and failure. Chapter 1 explains the basics of learning analytics, and Chapter 2 introduces global trends in the field. Looking at trends in Japan, Chapters 3 and 4 present the example of Kyushu University, which is currently implementing the most advanced initiatives, as well as efforts throughout Japan. Finally, Chapter 5 examines the future of learning analytics and some of the challenges involved.

This book is available now at major bookstores nationwide at a pre-tax price of 760 JPY. Visit NII's website for information about previous publications in the Jouhouken Series.
http://www.nii.ac.jp/about/publication/jouhouken-series/

[1] Authors: Masako Furukawa (Assistant Professor, Information and Society Research Division, NII), Kazutsuna Yamaji (Director, Research Center for Open Science and Data Platform, NII; Professor, Digital Content and Media Sciences Research Division, NII), Hiroaki Ogata (Professor, Academic Center for Computing and Media Studies, Kyoto University), Shinichi Konomi (Professor and Director of Learning Analytics Center, Faculty of Arts and Science, Kyushu University), Keiko Takarabe (Copy Editor and Writer)

NEWS 6

Conclusion of MOU with University of Zurich

Promoting international exchange and research collaboration

On January 17, NII concluded an international exchange agreement (MOU: Memorandum of Understanding) with the University of Zurich, Switzerland.

Before the signing ceremony, a workshop was held at NII, where researchers from both organizations had lively discussions on the direction of joint research in each subject, including human interaction with the Semantic Web, and blockchains and economic networks.

The signing ceremony, held at the residence of the Ambassador of Switzerland in Tokyo, was attended by the University of Zurich's Vice President Christian Schwarzenegger and NII's Director General Masaru Kitsuregawa and Deputy Director General Ken-ichi Kawarabayashi, who signed the MOU.

Essay

To students aiming to become experts: Do research that you can explain

Naoko Takahashi
Professor (special full-time),
Faculty of Economics, Kokugakuin University
Director (Education), Information Processing Society of Japan
Working Group Member,
JST GSC Experts in Information Science

To all junior and senior high school students aiming to become information science experts, whatever the state of the world around you, please do not miss your lucky chance. Seize it without hesitation. After all, good luck is not something that you can set aside for next year. One might say that fortune favors the talented, and the luck that has come to you now is something that you yourself have summoned.

After seizing your lucky chance, you will receive guidance and learn from many people, not only about the contents of research but also the approaches and technical methods applied when tackling such research. Please be sure to make a note of the things you are not good at and consciously work on them. In the process, they will gradually become unconscious habits. Accumulate lots of knowledge, hone your skills, and become a true "expert" by the end of the program.

Becoming an expert means becoming able to explain what you have done. No matter how difficult the research, no matter how amazing the invention or astonishing the discovery, it is useless if no one else understands it. It is important to be able to explain objectively what you have worked on, the invention or discovery, so that other people can understand it. One form of explanation is the report or paper, but they are not easy to write. To explain something, you need to know what other people know and what they need, and then structure your explanation accordingly. For this, it is vital to take notes of what you have done, organize the information, get rid of anything that is superfluous, and express it in a way that is easy to understand. In other words, it is important that you do not simply get absorbed in your research, but review it objectively by taking notes.

To write a good report or paper, find one that will serve as a model and copy the template. To find a report or paper that will serve as a model, observe what other people are doing, listen to them, and read lots of information. Read relevant journals and technical books, as well as reports and papers. As you do, find ways of explaining and writing that you think are easy to understand and expressions that you like, and create your own template. Research that is explained clearly will at some stage catch someone's attention and perhaps be made use of. In short, to become an expert who can explain what they have done, do not neglect reading. Be sure to gain reading skills.

Finally, as I write this essay, not only Japan, but the whole world is suffering under the COVID-19 pandemic. I hope that the pandemic is easing by the time this publication reaches you.

Information

Screening of Takano Lab research results

"Museum of the Future: created using digital archives of cultural heritage and informatics"

From February 25, NII is screening images of the research results of Takano Lab (Professor Akihiko Takano, Digital Content and Media Sciences Research Division) on the first floor lobby of the National Center of Sciences (the building that houses NII's main departments)[1] (see photograph).

In "Museum of the Future: created using digital archives of cultural heritage and informatics," you can see a diverse range of research results that Takano Lab has been involved in, such as "ScienceNavi," "Kyoto Kasane Chizu," "The Meiji Period on Film," "Japanese Animated Film Classics," "Cultural Heritage Online," "Ocha Navi/KS46 Wall," and "Promenade System." Also included is a presentation movie titled "Glass Photographic Plates of the Murals in the Kondō Hall of Hōryūji Temple: The World of the Kondō Hall Murals Brought Back to Life," which was created for a special exhibition at the Nara National Museum.

[1] Scheduled to be screened until the end of June. Generally, weekdays only.

SNS

"Hey, this is great!" Hottest articles on Facebook and Twitter (December 2019-February 2020)

*Some text edited/ omitted.

National Institute of Informatics, NII (official) Facebook
www.facebook.com/jouhouken/

[News Release]
NII starts operation of a 400 Gbps Tokyo-Osaka link to speed up SINET, the ultrahigh-speed network supporting Japan's academic research—Putting world-leading high-capacity line into practical operation over long distance
(12/11/2019)

National Institute of Informatics, NII (official) Twitter
@jouhouken

[Recruiting junior and senior high school and technical college students interested in the cutting-edge informatics research!]
Recruiting participants for the National Institute of Informatics Global Science Campus (GSC) the JST GSC Experts in Information Science 2020
(1/14/2020)

Bit on Twitter! Twitter
@NII_Bit

Last week, NII visited National Institute of Technology, Kurume College!
Associate Professor Mahito Sugiyama gave a lecture on machine learning and data mining!
You can download the lecture materials from Assoc. Prof. Sugiyama's website (12/11/2019)
https://mahito.nii.ac.jp

Notes on cover illustration

The round-faced student robots are visiting a laboratory where cutting-edge research is being conducted. They are eagerly taking notes as they learn at the side of the researcher robots.The JST GSC Experts in Information Science provides an opportunity for young talent to experience cutting-edge informatics research.

Weaving Information into Knowledge
NII

National Institute of Informatics News [NII Today]
No. 73 Mar 2020
[This English language edition NII Today corresponds to No. 87 of the Japanese edition.]
Published by National Institute of Informatics, Research Organization of Information and Systems
Address | National Center of Sciences 2-1-2 Hitotsubashi, Chiyoda-ku, Tokyo 101-8430
Publisher | Masaru Kitsuregawa Editorial Supervisor | Ichiro Satoh
Cover illustration | Toshiya Shirotani Copy Editor | Madoka Tainaka
Production | MATZDA OFFICE CO., LTD., Sci-Tech Communications Inc.
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