

NII Today

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Feature

Don't Stop the Education!

Two years of the
“DX Symposium for Educational Institutions”

P3 ▶ **Special Dialogue** Classwork Digitalization for Data-driven Education
HAKUI, Yoshinori × KITSUREGAWA, Masaru

P9 ▶ **Interview** Digital Transformation of Education is Changing Social Norms!
YASUURA, Hiroto

P12 ▶ **Roundtable①** Data Analytics is Shaping the Future of Education
SHIMADA, Atsushi; SHIGETA, Katsusuke; OGATA, Hiroaki; MORI, Kensaku

P16 ▶ **Roundtable②** Future Directions from the Viewpoint of Educational
Information Infrastructure

**FUKUZAWA, Yoshiaki; KITA, Hajime;
TAKEMURA, Haruo; SUGANUMA, Takuo**

P20 ▶ **Secretariat Staff Speak** Behind the Scenes of the
“DX Symposium for Educational Institutions”

Research [Towards the Post-COVID Era]

P22 ▶ **An Investment Money Analysis System to Ensure Economic Security**
MIZUNO, Takayuki

P24 ▶ **Technical Challenges for Next-generation Mobile Networks**
KANEKO, Megumi

P25 ▶ **Column** The Search for the Shape of Virtual Space Continues
IKEHATA, Satoshi

▶ **Essay** A New Normal for the Next Generation, Due to COVID-19
FURUKAWA, Masako





At universities and other educational institutions around Japan, online classes are being introduced.

To promote digital transformation (“DX”) in education, in March 2020, NII began running its “DX Symposium for Educational Institutions.”

That was two years ago!

Issue 94 of “NII Today” discusses the current state and challenges of the digital transformation process in education and the contribution that NII can make to this effort in a post-COVID-19 world.



[Feature]

Don't Stop the Education!

Two years of the
“DX Symposium
for Educational
Institutions”



In March 2020, NII launched an initiative titled “Cyber Symposium for Sharing Information on Distance Learning Efforts at Universities for the New Academic Year.” In 2022, despite changes to the name and character of the meetings, the symposium is still running. In these two years, it has played a vital role in preventing disruption to education in the face of the COVID-19 crisis. NII Director KITSUREGAWA, Masaru sat down with HAKUI, Yoshinori, Director-General of the Elementary and Secondary Education Bureau of the Ministry of Education, Culture, Sports, Science and Technology (MEXT), to talk about the trajectory of the initiative and where it is headed.

Special
Dialogue

Director-General, Elementary
and Secondary Education Bureau, MEXT

**HAKUI,
Yoshinori**

Director General, NII

**KITSUREGAWA,
Masaru**

Interviewer

**TAKAHASHI,
Mariko**

Journalist, former science coordinator at the Asahi Shimbun

Classwork Digitalization for Data-driven Education

—Let's start with a simple question. In January 2021, the name of the symposium changed to “Cyber Symposium on Online Education and Digital Transformation in Universities and Other Institutions,” or more simply “DX Symposium for Educational Institutions.” What was the thinking behind this change?

KITSUREGAWA: Firstly, I don't have much sense for names. It turned out long and cumbersome. The reason is that research grant applications allow only a limited

number of characters for titles. Just writing “computer” or “operating system” takes up so many characters. I find it unpleasant to come up with titles, so I tend to use longer names whenever I'm free to do so. Otherwise, the intention doesn't get communicated. There was also some ambiguity in the original title about the time-frame, which we wanted to eliminate. And the other reason is that we wanted to discuss digital transformation (“DX”) more broadly. Everyone was talking about “DX”

and the ministry (MEXT) was calling for digital transformation in education and research.

—I think the original name conveyed a sense of urgency, but it was definitely too long. Did news about the symposium reach the ministry immediately?

Initially, there were no plans for online classes for elementary and junior high schools

HAKUI: When the initiative started, I was head of the Higher Education

Bureau, so I knew about it right away. Thinking back, although all the elementary and junior high schools in the country had been suddenly closed by government decree, there was no real idea of running online classes at those levels. The symposium was started to discuss how to keep university classes running. If I recall correctly, the meetings were held every Friday, starting around late March. It was a groundbreaking and marvelous initiative. I took part myself a few times.

KITSUREGAWA: I'm impressed that you remember that the meetings were weekly. After every meeting, we received many expressions of gratitude and requests. "Please do this, please do that." I had never been thanked so much in all my life, so when I was asked to do something, I felt obliged to do it. Together with the heads of the IT centers of the seven national universities and other professors, I struggled to run the symposiums once a week. At a certain point, though, one of our staff said, "If we

go on like this, we'll die of overwork." I basically agreed, so we reduced the frequency. We're now used to using online conference tools, but at that time, no one had a clue. We couldn't outsource the work, so the NII staff had to struggle valiantly through many frustrations to figure things out.

The symposium evolved to feature digital lectures

Same on the university side. Private universities in particular lacked IT specialists, so many of them had a very hard time. Somehow, by around the end of 2020 we managed to make things work. In effect, we were able to connect everything together.

In the next phase, the challenge was to think seriously about how to offer digital lectures in an optimal way. Like this, the symposium evolved. We got a lot of requests, especially from nursing schools. Given the need to train more nurses to deal with the COVID-19 crisis, we were getting waves of requests to help introduce some

advanced initiatives.

—Of course, practical training is indispensable for nursing education.

KITSUREGAWA: Yes. There was an interesting report claiming that digital is actually better for nursing practice. Why is that? Well, normally, to observe a patient, students surround the bed. But often only those at the front can see clearly; those at the back find it difficult. With a digital setup, multiple cameras can be used to show the patient from different sides. At some point, face-to-face practice becomes essential, but the digital method was regarded as highly effective for teaching before that point.

—How did these changes appear to you over this period, Mr. Hakui?

HAKUI: Firstly, I want to cite a survey conducted in 2019 about the use of ICT by universities. Around 36.4% of universities were doing at least a small amount of online teaching with video on demand, with 32.6% doing real-time online

We want to support online education for elementary and junior high schools, but school teachers struggle to participate in symposiums, so it's difficult for us to connect with those actually teaching.

**KITSUREGAWA,
Masaru**



teaching. Then with the COVID-19 crisis, virtually all universities, as well as nursing schools and other vocational colleges, started doing some form of online education. But first, a suitable telecommunications environment had to be set up. That costs money. And students also faced additional costs. We faced the question of what to do about it. On the university side, the ministry (MEXT) provided support through supplementary budgets and other measures.

The next issue, naturally, was the quality of classes, as Dr. Kitsuregawa alluded to. The ministry has worked to collect and share detailed examples of good practices at various universities. We've also looked at how we can use online methods as alternatives for practical training, for practical skills in physical education, and for performance and practical work at art-related universities.

University life is more than classwork

—I'm very impressed by the

strenuous efforts of everyone involved in getting online classes off the ground. However, for students, university life is not just about classes. Club and circle activities are also vital.

KITSUREGAWA: There's a lot of discussion about that topic. HAGIUDA, Koichi, who was the minister at the time, pushed very strongly for face-to-face classes, as far as possible.

HAKUI: As the summer approached, there were increasingly loud protests of dissatisfaction about the lack of club and circle activities, and the inability to use libraries to properly continue research activities. The issue was raised many times in the Diet, so the minister could not disregard it. The minister called for the return of face-to-face classes, or at least for the reopening of libraries to allow students to continue their studies. Furthermore, believing that educational activities are not limited to the classroom, the minister began to conduct detailed inquiries into what universities were doing be-

yond the classroom and publicizing the findings.

In March 2021, a random sample of 3,000 students across Japan was surveyed to find out how students were adapting to online classes. There were a little over 1,700 responses. We found that in the second semester of 2020, 60% of students took most or all their classes online. In terms of their reaction, around 60% of respondents felt "satisfied" or "somewhat satisfied" with online classes. According to the survey, one of the best things about online classes is the ability to study at one's own pace, cited by 66%. Many students, 79.3%, enjoyed the freedom to take classes where they chose. Some students, 14.7%, even felt that online classes were easier to understand than face-to-face classes.

The most common negative point was that students felt lonely because they couldn't be together with friends. This was a problem for 53%. Another common complaint was too many reports and

If the ministry (MEXT) supports the NII symposium, it will be easier for elementary and junior high school teachers to participate.

HAKUI, Yoshinori

After graduating from the Faculty of Law at Kobe University, joined (the then) Ministry of Education. After serving as Director of the Textbook Division of the Elementary and Secondary Education Bureau and Director of the Financial Affairs Division of the same bureau, was appointed Deputy Director-General of the Ministry of Education, Culture, Sports, Science and Technology (MEXT). Worked on reforming university entrance examinations. In 2019, was appointed Director-General of the Higher Education Bureau. Assumed current position in 2021.

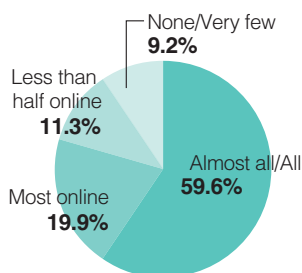
other assignments, 49.7%. Some 43% felt that there were too few opportunities for asking questions and interacting with others. And 42.7% felt that online lessons were harder to understand.

KITSUREGAWA: Students were able to adapt quite easily. Actually, it was university instructors who had the toughest time. Shifting all their lectures online in such a short time was a terrible challenge. The majority of symposium participants were instructors. The ministry also explained the measures and system changes repeatedly in the meetings. In the process of organizing the symposium, government offices and instructors connected directly, and we felt a strong mood of mutual support between the seven national universities, NII, and other secretariats. Nothing like that had ever happened before.

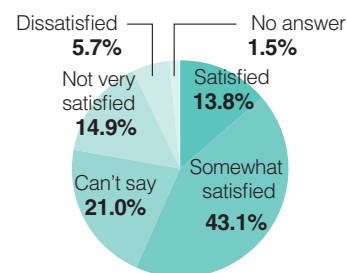
Wanting to support elementary and junior high schools too, we reached out to invite elementary and junior high teachers to join us for discussions, promising that universities would do whatever possible to help them. We haven't been able to make very broad connections, however. It seems that

60% of university students felt "satisfied" with online classes

Proportion of online classes



Satisfaction with online classes



Based on "Survey on the Impact of COVID-19 Pandemic on the Life of Students" by MEXT (conducted March 2021).

https://www.mext.go.jp/content/20210525-mxt_kouhou01-000004520_1.pdf (in Japanese)

teachers struggle to join the symposiums. Although we've been discussing elementary and junior high school topics at every symposium recently, only 5 or 6% of participants are from elementary or junior high schools, a disappointingly low figure.

How should online classes at elementary and junior high schools be promoted?

HAKUI: Under the GIGA School Program to accelerate digitalization, elementary and secondary schools were provided with one digital terminal per student. Instead of four to five years to reach this goal, students were able to start using their devices in the 2021 school year. But this has led to a mountain of challenges.

One simple reason why elementary and junior high teachers find it difficult to attend symposiums is a lack of time. Their class schedule is basically packed. One way to make the Board of Education at least

aware that they can watch videos of the symposiums in the workplace when they have time is to make it clear that the Elementary and Secondary Education Bureau is supporting NII's DX Symposium. This would make it easier for teachers at schools to plead to their principals and Board of Education for help.

KITSUREGAWA: Well said! We would love to create an elementary and junior high school version of the DX Symposium for Educational Institutions. Since the ministry is supportive, we can discuss this openly with them. Right now, NII is trying to work out exactly how to deal with all the student data associated with education under the Personal Information Protection Law. We are going to anonymize the data for use by university pedagogy professors. I think NII can help by creating a forum for discussion that includes education researchers, elementary and junior high school teachers, and the min-



"Digital" should never be the goal. Decide what you want to do, then think about how to use digital technology.

That's right!
ICT is just a tool, like stationery.
How do we best make use of it?



istry.

There is a U.S. study I want to mention. Comparing three methods of learning (all face-to-face, hybrid (a combination of face-to-face and remote), and all remote), it found that face-to-face learning is best for elementary schools: all-remote learning leads to a dramatic drop in scholastic performance. At the junior high level, however, the influence of remote learning is insignificant (bottom right graph). The point is that I've never even heard of this kind of quantitative analysis in Japan. This is a serious worry, I think.

Education policy has been shaped on the basis of episodes

—I've long felt the same way. Japan is very weak in measuring the results of education. Which means that we can't have discussions grounded in data.

KITSUREGAWA: In the Council for the Implementation of Education Rebuilding in 2020, I pushed the idea of making education more data-driven. Surprisingly, many of the education professionals agreed with me. In the end, the term "data-driven education" was included at the beginning of the 12th proposal. So, I think the move to making rigorous use of data is gaining ground.

HAKUI: Since everyone has experienced school education, policy-makers have inevitably been influenced by their own experiences

when making decisions. The ministry is now finally starting to make more evidence-based policy decisions. We are promoting small class sizes and a subject teacher system in elementary schools, for example. To figure out policy, we need to collect evidence on how measures specifically impact both the academic performance and life of students. However, we lack knowledge, expertise, and experience in collecting such data. That's the reality. So, we will continue to partner with universities and research institutions for all of this.

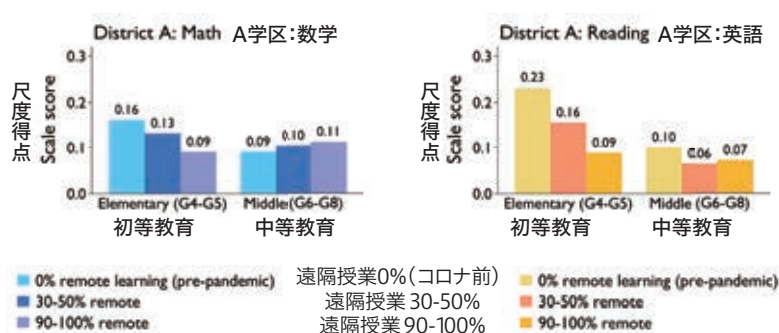
KITSUREGAWA: We can certainly work together on these things.

HAKUI: We are now taking full advantage of the fact that every student has a terminal to keep a study log of each student's learning history. We are moving to utilize this information for learning assessment, for developing school initiatives, and for education policy. We are also promoting the use of

Computer Based Testing (CBT) for the National Assessment of Academic Ability, which is usually conducted each year in April. As far as data utilization goes, various issues still need to be resolved, but this is another big step forward. We are also working to standardize educational data, for example, by assigning a code to each unit of the "Course of Study" to facilitate the creation of databases for different kinds of teaching materials.

—In promoting digital transformation in education, I think it's vital that there be no mistakes in the principles and objectives.

Performance improvement rate per day by education method



Sass, Tim. "COVID-19 and Student Learning Impacts." Georgia Policy Labs. Last modified May 13, 2021. <https://gpl.gsu.edu/download/student-achievement-growth-during-the-covid-19-pandemic-webinar-slide-deck/?wpdmdl=2108&refresh=61f7fc7b342b21643641979>.

Personally, I want to see the workload of teachers reduced, while for children, I hope to see a shift away from that peculiar Japanese insistence that everyone has to be the same. I hope that “DX” can help with this.

HAKUI: You are right. It's not necessarily true that advances in ICT have reduced our workload. Reforming the way teachers work is currently one of our biggest challenges, and we are promoting ICT use in a way that helps achieve this goal. We also need to use ICT in new and innovative ways to try and maximize the potential of children who need extra support, like kids with attendance issues.

Promoting evidence-based education by linking universities with elementary and junior high schools

KITSUREGAWA: I was surprised to learn through the DX Symposium that remote learning can be a lifesaver for students who are chronically absent from school. I want to mention another thing, regarding personal information; the inability to consolidate data because of the huge number of variant laws and regulations governing personal information across the local governments of Japan. Under the federal system of the U.S., states have a great deal of autonomy, so in theory the U.S. faces the

same challenge as Japan. However, the U.S. government manages to effectively collect national education data. Its EDFacts initiative (a system for collecting data on elementary and secondary public school education programs nationwide) offers a comprehensive picture of schooling. Many research papers make use of the EDFacts data. Unfortunately, Japan lacks a data collection system like that. It is strange that we cannot collect data in bits and pieces because of the issue of personal information regulations. If we want to aim at a “data-driven” system, this issue definitely needs to be discussed. The most urgent thing is understanding the disparities in education across the country caused by the COVID-19 pandemic.

One of the points I constantly make in my lectures is that “digital” should never be a goal. You first decide what you want to do and then think about whether digital technology can help to achieve it. As a long-time IT researcher, I insist that it is vital to start from scratch, to take a hard look at things; firstly at what the future of student education should look like, and then at how that vision can be supported with digital tech.

HAKUI: That's right! ICT is just a tool, like stationery. It's a matter of working out how best to use it; like we used to do with stationery. To

move forward with an evidence-based approach, there needs to be organic collaboration between the classroom and university research, so that we can produce solid data based on statistical mathematics. For me, today's dialogue has reaffirmed how important it is to figure out how to connect the world of university research with the world of elementary and secondary school educational practice.

A Word from the Interviewer

A Word from the Interviewer
Education needs to be more evidence-based. There was complete agreement on this point. It was also clear that the scope of the DX Symposium is being expanded to cover elementary and secondary education. One of the great things about the DX Symposium is that it enables people of different positions and standpoints to talk to each other on an equal footing. I experienced this firsthand when I joined the symposium in its early days. This is something Japan is typically not good at, due to the tendency for hierarchical relationships to come into play. I hope that the “new DX Symposium” will help to dispel some of that old culture.



TAKAHASHI, Mariko

Journalist and former science coordinator at the Asahi Shimbun.

Graduated with a degree in physics from the Faculty of Science at The University of Tokyo. In 1979, joined the Asahi Shimbun, working as a reporter in the Science Department at Tokyo Head Office, editorial staff for Kagaku Asahi (“Science Asahi”), editorial writer (on science and technology, and medicine), deputy chief of the Science Department, and science editor (general manager) before leaving the newspaper in 2021. Publications include “Gravitational Waves: A Discovery!” (Shincho Sensho).

DX Symposium for Educational Institutions

Two years after its inception, it has evolved to lectures in the metaverse



NII's “DX Symposium for Educational Institutions” continues to evolve. The 45th symposium, held on January 14, 2022, featured a lecture in the metaverse by FUJII, Teruo, president of The University of Tokyo. Dr. Fujii appeared together with NII Director Dr. Kitsuregawa as photo-realistic 3D avatars in a lecture hall set deep in the sea. The lecture was attended by 1,700 people.

► See p.27 for more details.



[Interview]

Digital Transformation of Education is Changing Social Norms!

YASUURA, Hiroto

Chief Cyber Science Infrastructure Director, NII
Information Committee Chair, Council for Science and Technology,
Ministry of Education, Culture, Sports, Science and Technology (MEXT)

Interviewer

MASUTANI, Fumio

Senior Staff Writer, Asahi Shimbun

Digital transformation (“DX”) in education is now underway, most actively at universities. To shed light on the challenges that are emerging, we asked the Chief Cyber Science Infrastructure Director at NII about the directions that DX needs to head in over the coming years.

—In what fields of university education do you expect to see the biggest advances and impacts from digital transformation?

At the outset, I want to stress that DX is not the same thing as advances in IT.

First of all, advances in IT have enabled digital technology to be incorporated into the existing model of education and work. The online classes that were suddenly launched at universities nationwide

after the COVID-19 outbreak are a typical example of this.

However, some of the university teachers who had originally promoted greater use of IT in education felt that that this great leap forward in online education would now serve as a great opportunity for DX. So, they began to use IT to radically change education, research, and work processes.

Money and talent sharing are essential for bridging the gap between universities

—Could you provide a simple example of how DX in education has progressed?

OK! Let’s take the example of the professor’s rounds in medical TV

dramas like *Shiroi Kyotō* (“White Huge Tower”). In this educational method, a professor of medicine makes the rounds of patients in a university hospital, accompanied by doctors and students. When this is done face to face, students at the back cannot fully grasp the interactions between the professor and patients.

During the COVID-19 crisis, though, the professor was followed by only one person, to film the interactions. The students were then able to watch the video online. They reported that this method was more educationally effective than the face-to-face method because they were able to discern the professor’s words and movements more clearly.

On the other hand, this method has limitations. The screen doesn't show everything that students need to pay attention to, such as the movement of nurses around the bed or the anxious expressions of family members. By training like this, there is a risk that students might not pay attention to these details when they become doctors. So, with current technology, online education is not always clearly better than face-to-face education. We need to consider which method is more effective on a case-by-case basis.

—Many universities seem to be offering the classes usually held in large lecture halls online.

Yes, it can be difficult for students sitting at the back of a large hall to see the writing on blackboards or to hear the lecturer's voice. But even apart from the students at the back or students who chat and distract others, classes in large lecture halls are not very effective in terms of learning efficiency.

In online classes, on the other hand, the interaction between students and the teacher is more one-to-one. When students have their camera turned on, they tend to be more attentive and alert than they would be in a large hall.

Online classes also allow teachers to try out new educational methods, if they wish to. SHIMADA, Atsushi, a professor who teaches information science at Kyushu University, uses a technique called Learning Analytics (LA) to track which pages of an electronic textbook each student has open in the cloud.

Data such as the results of in-class tests can be used to identify the precise points where students tend to lose their way, according to faculty, class format, learning method, and other factors. If these data are shared among teachers, it can also

increase educational efficiency by helping teachers to design classes and guide students in better ways.

—Some universities are lagging behind in DX.

There is a feeling that the disparities between universities are growing. One big factor behind the lack of DX progress at regional and small universities is a lack of money and suitable personnel.

In these cases, we recommend that several universities share in a project. With the local national university playing a leading role, the universities could pool their resources to build the infrastructure they need for DX. Another idea is to share resources across regions, for example, between technical colleges.

Collecting data can help to improve the “Course of Study”

—Every elementary and secondary school student in Japan is getting their own personal digital terminal.

Elementary and secondary school education teaches the same contents throughout the country. As DX advances, the educational data on a child captured by a single teacher can be shared with other teachers of the same grade, teachers of different subjects, and even across the whole school.

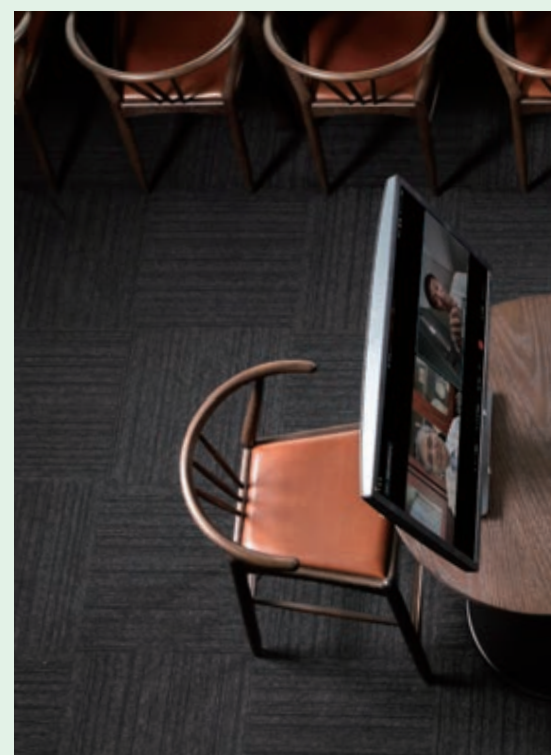
And if anonymized data were collected nationally, we might find that many children are stumbling at the same points. Such findings could stimulate discussions along the lines of, “Let's revise the course of study because the study units are not designed very well.”

—When information is shared, many things can be visualized, can't they?

We could, for example, determine what percentage of Japanese children or citizens are aware of infor-

mation that should be common knowledge in today's society, like the characteristics of the coronavirus.

Analyzing the data would also allow us to figure out what should be taught to the Japanese children of today in schools, and what things they could best learn outside of school. Changing the content of education in response to changes in social circumstances makes it possible to change the “common sense” of citizens to suit the times.



—Nevertheless, there are also areas where it is difficult to see the benefits of DX in education.

Of course, there are limitations with the technology at this stage. The field of mental care is one example. We can't expect people who meet each other for the first time online to open up to each other immediately. The environment is not yet ready for that.

Universities are a place for education of the whole person, so DX is never going to cover all their func-

tions. Students learn much more from human interactions with friends and teachers than from classroom study. The value of learning in the close company of friends is enormous.

—It is striking that although DX is a means to an end, it seems to have become a goal in its own right.

Certainly, in Japan the buzz term “DX” is everywhere. We need to get our priorities straight. Above all, we need to think about the kind



of system and society that we want to create. Only after that should we worry about how to utilize DX to help achieve our goal. Some universities are now moving to utilize virtual reality (VR) in education. Adopting available technology is a good thing, but we should not be satisfied to leave it at that; more effort is required. Until VR technology advances to the point at which students feel that they are really shaking hands with other people, it won't be able to replace

face-to-face instruction.

—I get the impression that DX is more evolved at Western universities. Is Japan lagging behind?

In the DX Symposium for Educational Institutions, which NII has been running for the past two years, we received numerous reports from overseas universities. It seems that, just as in Japan, many universities in Europe and the U.S. started online classes in response to the COVID-19 pandemic.

Some of the leading universities in the West have long been enthusiastic about massive open online courses (MOOCs). The purpose of offering online education at low cost was to attract excellent students living abroad or far away. They were never really set up to offer online classes for regular campus-based students.

Governments are starting to recognize the importance of DX for research

At the same time, the EU and U.S. are investing huge sums of money into building infrastructure for digital transformation of research. Such systems make it easy to manage research data securely to prevent data breaches. At the appropriate time, they make it possible to instantly share data in a format accessible to anyone.

For the first time, in its FY2022 budget bill, the Japanese government provided specific funding for research DX. It now recognizes that properly managing and storing empirical data is just as important as writing papers. NII is at the center of a plan to create a basic mechanism for that purpose.

—What does Japan need to do in this area over the coming years?

What we do will be critical for the country. How do we manage and utilize research data without secu-

rity risks? This is an issue that needs to be considered and tackled not only by NII when creating information systems but by the whole of society. It is vital to draw a clear line to determine what is an invasion of privacy. We shouldn't just follow the rules made by the West. In my view, Japan should get actively involved in formulating data rules to enable the creation of systems that are easy for us to use.

A Word from the Interviewer

How will NII and the government contribute to the digital transformation (“DX”) of universities and other schools in the future? This was the specific question I intended to ask, but educational DX is a grand story that expands well beyond the confines of the classroom.

When educational DX gets going fully and leads to educational reform, it could even reshape the “common sense” of the Japanese people to make it better suited to the times. This was truly an eye-opening discussion. I realized that we are at the beginning of a massive transformation. I also gained a new perspective that will prove valuable when I report on education in the future.



MASUTANI, Fumio

Senior Staff Writer,
The Asahi Shimbun

After graduating from Osaka City University, joined the Asahi Shimbun in 1994, working in Tokyo, Osaka, Nagoya, Sendai, and Kyoto. From 2005, covered higher education intermittently for approximately eight years. From April 2020, served as a senior staff writer on higher education and from October 2020 has also worked as an editorial writer on education in general.

Data Analytics is Shaping the Future of Education

Changing teaching and learning methods and the role of universities

SHIMADA, Atsushi + SHIGETA, Katsusuke + OGATA, Hiroaki + MORI, Kensaku

Professor, Kyushu University Graduate School

Associate Professor, Hokkaido University

Professor, Kyoto University
Visiting Professor, NII

Professor, Nagoya University
Visiting Professor, NII

Profile (in no particular order)



SHIMADA, Atsushi

Professor, Department of Advanced Information Technology Graduate School of Information Science and Electrical Engineering, Kyushu University

PhD from the Graduate School of Information Science and Electrical Engineering, Kyushu University. Also serves as an advisor to the president of Kyushu University.



SHIGETA, Katsusuke

Associate Professor, Information Initiative Center, Hokkaido University
Associate Director, Center for Open Education, Institute for the Advancement of Higher Education

Graduated from Osaka University (PhD, Human Science). After working as an assistant professor at The University of Tokyo, was appointed to current position in 2013.



OGATA, Hiroaki

Professor, Academic Center for Computing and Media Studies, Kyoto University
Visiting Professor, NII

PhD in Engineering from Tokushima University. After working as a professor at Kyushu University, was appointed to current position. Visiting Professor at NII since 2020.



MORI, Kensaku

Professor, Graduate School of Informatics, Nagoya University
Director, Information Technology Center, Nagoya University
Visiting Professor, NII
Director, Research Center for Medical Big Data, NII

PhD in Engineering from Nagoya University.

Digitalization of education is about more than holding classes online. The growing deployment of learning management systems (LMS) and the potential of learning analytics (LA) are radically changing both how we teach and how we learn. The four panelists discussed current trends in this area, along with the issues they see and prospects for the future.

—There is a feeling that the COVID-19 pandemic has suddenly accelerated the digitalization of education. What are some of the actual changes that stand out most strongly to you?

OGATA: Digitalization was happening gradually even before COVID-19, but all at once the process has taken a big leap forward.

While I was at Kyushu University, I developed BookRoll, a digital teaching material viewing system, and I've been operating a digital learning environment called LEAF that combines BookRoll with an **LMS.*1** I'm using LEAF as a core tool for collecting learning data. BookRoll is available to everyone at Kyoto University. Before COVID, only about 20 to 30 courses were using it, but by 2020, this number had risen to about 500.

MORI: Since around 2010, I've been involved in operating and managing an LMS called NUCT*2 at Nagoya University. Before COVID, NUCT was available university-wide, but while some teachers used it, others didn't. After COVID, however, all teaching was run using NUCT. This shift provided the motivation to digitalize more and more of the university's teaching content. It's been very interesting to see how this has spawned a variety of movements, like the creation of VR class content.

Another big change is that students are now looking at the LMS every day. It feels like attending university is now effectively synonymous with using the LMS.

SHIGETA: At Hokkaido University too, all the teaching staff began to use the LMS after the pandemic started. There's been a broad move for teachers to create and post videos of their lectures, as well as other teaching materials. So, things have changed dramati-

cally. So far, mainly through its Center for Open Education, which I currently head, Hokkaido University has created **Open Educational Resources (OER)**^{*3} on a university-wide basis. It has also incorporated OER into regular classes, to try to integrate face-to-face classes and online education. Now it definitely feels like online education has progressed rapidly and urgently.

SHIMADA: In terms of utilizing educational data, or **LA**,^{*4} as online education has gone mainstream, teachers, and also students, are making increasing use of LA tools.

Whereas students previously shared space in a classroom, they now connect from their homes for online classes. The education environment has therefore become more fragmented. As a result, the use of LA tools has expanded because they make it easier for students to take classes or else make them feel less isolated as they can get some sort of feedback. The ability to extend the benefits of LA to students has been a remarkable change.

Know-how for digitalization still needs to improve

—Many challenges have come to light in this process, I believe.

OGATA: I see three major benefits in the digitalization of education: (1) Higher efficiency in teaching and learning activities due to the shift from analog to digital; (2) The ability to use totally new educational methods through the use of virtual reality (VR) and other technologies; and (3) Improved teaching and learning through recording and analysis of teaching and learning processes. This latter point corresponds to LA. While we have taken big steps with (1) and (2) thanks to COVID, we are just at the beginning with (3), that is, LA. We've made some progress in analyzing logs to understand student behavior and performance, but there are challenges ahead, because analyzing data and using it to support learning will be a high hurdle for many teachers. It is essential to solve systemic problems and improve user interfaces, but teachers also need to change their thinking to try and make skillful use of learning data in the classroom.

SHIMADA: Absolutely! To increase the utilization rate of LA tools further, it's important to improve interfaces to make them easier to use and help users to understand how they can access the information they want quickly.

At the same time, I want to see more teachers who feel passionate about making use of data to help them teach more effectively.

MORI: When it comes to putting together digital classes, it's clear that the attitude of teachers needs to change. In face-to-face classes, it was possible to divide up courses into class sessions quite flexibly, keeping an eye on students' faces to gauge the appropriate pacing. However, with digital classes, you need to divide courses

“The ability to extend the benefits of LA to students has been a remarkable change.

(Shimada)

Outline of LEAF



(Source: Prof. OGATA, Hiroaki, Kyoto University)

Overview of the LEAF digital learning environment, which Prof. OGATA is developing and operating as the basis for his LA research. Information obtained from the LMS and BookRoll, a digital viewing system for teaching materials, is accumulated and analyzed to enhance learning in sophisticated ways, by visualizing learning comprehension levels, identifying stumbling blocks, and assisting in grouping learners.

^{*1}

LMS = Learning Management System, a system for the comprehensive management of student attendance and learning progress, as well as management and distribution of digital teaching materials.

^{*2}

NUCT = Nagoya University Collaboration and Course Tools, an LMS that Nagoya University has used since April 2010.

^{*3}

OER = Open Educational Resources, digital teaching materials made freely available on the Internet for anyone to use by Hokkaido University through the Open Education Center.

^{*4}

LA = Learning Analytics, an initiative to collect and analyze big data related to learning, such as class learning performance (in addition to traditional test-based academic performance measurements) and feeding the data back to optimize teaching.

Data Analytics is Shaping the Future of Education

*5

Instructional design is the systematic design of classes and teaching materials to achieve prescribed learning outcomes.

“I want to see more teachers who feel passionate about making use of data to help them teach more effectively.

(Shimada)

“We need to create content that holds people’s interest, even when there is no audience physically present, like YouTubers.

(Mori)

rigidly into numbered units of content: Part 1, Part 2, etc.

Radio DJs and YouTubers manage to create very compelling content by talking without an audience that is physically present. This focus on creating content that maintains the interest of people who are not immediately present has been lacking up to now. We have had a lot of discussion about how to maintain interactivity in online classes. On the other hand, the emphasis on interactivity has gone overboard in some cases.

SHIGETA: As Prof. Mori said, I feel that the art of teaching online is still in its infancy.

In the field of e-learning, which has always been my main research focus, we talk about **instructional design**;^{*5} methods for designing lecture content based on learning motivation and learning goals, and for providing appropriate support based on the learner’s progress. However, even in universities, this know-how is only partially utilized.

The growing potential of learning analytics

—How do you see things evolving in the coming years?

OGATA: Firstly, advances in LA will make it possible to tailor teaching and learning methods and styles to suit individual teachers and students. I anticipate advances in this kind of optimization for individuals.

At the same time, data will be collected from every class and accumulated by schools and even nationally. I would like to see masses of data anonymized and shared widely, to help the spread of evidence-based education, so we can assess the effectiveness of different kinds of classes. Progress will happen in these two directions I think.

However, in the case of data accumulation, there is an urgent need to create a proper framework (policies and rules) for data formats and data utilization.

SHIMADA: I think the possibilities of looking at data across long time frames will expand over time. Due to the COVID-19 crisis, the LMS utilization rate has risen to nearly 100%. So, if this situation persists, we will be able to capture changes over long spans of time. This would make LA extremely valuable. On the other side of the coin, we also need to devise ways to be more precise in collecting learning data for LA.

MORI: Until now, universities have been constrained by class schedules to a large degree. In the case of engineering, for example, the things that must be covered are pretty much set in stone, leaving little or no space in the timetable for anything else.

If lecture content were available in an LMS, however, it could be viewed by anyone, at any time, from anywhere. It could even be viewed at double or triple speed, enabling students who are moti-

vated to learn independently to expand their minds and knowledge to unprecedented degrees. This is a very revolutionary development, I think.

SHIGETA: One of the keys to success of LA is to grasp the learning progress of students so that we can get a broader picture of what kind of student profile corresponds to what kind of learning outcome. This would help to reduce the number of dropouts. Particularly in the past few years, universities have been accepting students with wide-ranging levels, so increasing numbers of students are struggling to keep up with their classes when conventional teaching methods are used. Therefore, if LA can be used to discover where the learning stumbling blocks are, it can be of great value in supporting students.

It is also important, though, to promote the development of the most gifted and talented learners, rather than just raising the average competency. For this, LA makes it possible to analyze the learning history of individuals, to determine what areas of study that they are most motivated about or most capable in. Such analyses could help such learners to develop their talents further in particular directions. I think this approach will become more important over time.

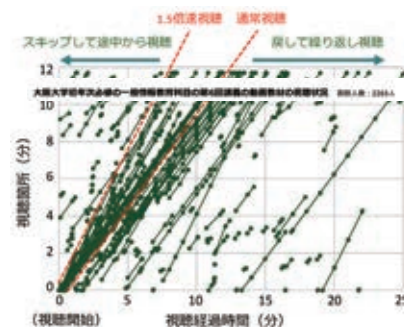
—The role of universities is likely to change, it seems.

SHIGETA: With their efforts in online education, universities are starting to see the potential of developing other forms of education services, independent of their campuses. I think that many are currently focusing on recurrent education.*6 In this regard, the role of local national universities as regional nuclei is also vital. Particularly in Hokkaido, with a population of only five million on a very large island, there is huge potential for online education. I believe that the time is ripe for universities to contribute more as stakeholders in society, by playing an active role as centers of territory and knowledge.

MORI: The management of Nagoya University and Gifu University were recently merged to form the Tokai National Higher Education and Research System. There is a plan to support regional learning through a common LMS for multiple universities. Each of the two universities currently use its own LMS, but they are moving to exchange data, with the aim of eventually switching to a unified LMS under the new system. The next step would then be offering the educational contents of the universities to people of wide-ranging ages in the Tokai region.

Three years ago, we could not have imagined doing all this. Before COVID, I didn't think that LMS use would grow very much, but suddenly, when the pandemic hit, people's attitudes changed. Suddenly, they felt like they could learn to use the LMS. I can see changes like this continuing to happen in many more areas.

Students watch classes at double speed



(Source: Prof. TODA, Tomoki, Nagoya University)

As a result of the shift to online classes, a new style of studying, by listening to lectures at high speed, is spreading among students, especially in liberal arts courses, which tend to be less interactive. It has been suggested that this may even lead to changes in the way students take classes.

“In the coming years, things will move in two directions: optimization of learning for individuals and evidence-based education.

(Ogata)

*6

Recurrent education means returning to study as and when needed after entering the workforce, through courses at universities and other educational institutions.

“Reducing the number of students who cannot keep up with classes, while at the same time helping gifted students develop their talent further

(Shigeta)

Roundtable

Education reform takes a big leap forward

Future Directions from the Viewpoint of Educational Information Infrastructure

FUKAZAWA, Yoshiaki + KITA, Hajime + TAKEMURA, Haruo + SUGANUMA, Takuo

Professor,
Waseda University

Professor,
Kyoto University

Professor,
Osaka University

Professor, Tohoku University
Visiting Professor, NII

Profile

(in no particular order)



FUKAZAWA, Yoshiaki

Professor, Faculty of Science
and Engineering, Waseda
University
President, Academic
eXchange for Information
Environment and Strategy
(AXIES)

PhD from the Graduate School of Science and
Engineering at Waseda University. Has served as a
member of the university's Executive Board and as
director of the university's library.



KITA, Hajime

Professor, Institute for Liberal
Arts and Sciences, Kyoto
University
Professor, Academic Center
for Computing and Media
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Withdrew from PhD program at the Kyoto University
Graduate School of Engineering with research guidance
approval. PhD in Engineering.



TAKEMURA, Haruo

Professor, Cybermedia Center,
Osaka University
Professor, Graduate School of
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PhD from the Graduate School of Engineering Science,
Osaka University. Has served as director of the
Cybermedia Center and director of the Teaching and
Learning Support Center.



SUGANUMA, Takuo

Director, Cyberscience Center,
Tohoku University
Professor, Research and
Development Divisions,
Cyberscience Center, Tohoku
University
Visiting Professor, NII

PhD from the Graduate School of Engineering, Chiba
Institute of Technology. Served as assistant professor
and associate professor at the Research Institute of
Electrical Communication, Tohoku University before
assuming current position.

In the past two years, universities have worked frantically to lay the foundations for an educational system to keep faculty staff and students connected.

What was happening on the ground? Where are things headed? Some of the professors who worked to set up the IT infrastructure to cope with the COVID-19 crisis discuss these questions and more.

—How did the COVID-19 pandemic impact your university's educational IT infrastructure and support systems?

KITA: Up until the end of the 2020 academic year, I was the director of the Institute for Information Management and Communication, which oversees ICT at Kyoto University. From the time the COVID-19 crisis was unfolding at the end of the 2019 academic year, I collaborated with the Center for the Promotion of Excellence in Higher Education, which is in charge of **FD,*1** to shift classes online.

Our learning management system (LMS), running on the Sakai (e-learning training support system) platform, was already linked to student registration. We also had a video delivery platform, Kultura, up and running. On top of this, we quickly acquired a university-wide license to use Zoom for web conferencing, linking it to Kultura through LTI (Learning Tools Interoperability). Almost all students had their own PCs, but inadequate Internet connectivity was a common problem. To address this, the Education Promotion and Student Support Department arranged to provide mobile routers. After the Golden Week holidays in spring 2020, we had issues with the LMS going down due to overloading, so we had to expand system capacity.

SUGANUMA: The Tohoku University Cyberscience Center handles the university's network infrastructure, as well as some planning and operational support for the services that run on the network. Tohoku University has a separate center for educational IT that we worked together with on responding to the challenges of COVID. At an early stage, we launched a university-wide working group to deal with online classes. The group, steered by the vice president in charge of IT, was made up of various relevant personnel. It was

designed to facilitate rapid top-down decision-making and action. In terms of dealing with the different issues that arose day to day, this system seemed to work well.

I think we were a little behind other universities in terms of digitalization, but shortly before COVID-19 erupted, we reaffirmed the importance of cloud computing within the university, so we were pushing ahead at that moment. I think we were just in time. If we had been even a little further behind, things would have been extremely tough for us.

TAKEMURA: At Osaka University, we were running a commercial LMS on our own servers, but in 2018 we migrated it to a data center. Then, late in the 2019 academic year, just as the COVID-19 drama was starting, we moved the LMS over to SaaS (Software as a Service). For video streaming, we had been using Echo360 for some time; this was already migrated to SaaS. For online class conferencing, we used Blackboard Collaborate Ultra university wide, with some use of Zoom and Microsoft Teams as well. These three tools were connected using LMS and LTI, for seamless operation.

We didn't have any serious concerns about system load or capacity, but the initial email support to help faculty staff with the various systems failed, so we scrambled to introduce a cloud-based CRM (customer relationship management) service.

FUKAZAWA: At Waseda, we faced the same systemic problems and education research issues as those already mentioned, with a few differences. I want to stress, that during the pandemic, the people at Waseda who had the hardest time were those in the university's IT department. When COVID took hold in the spring of 2020, virtually all employees were able to work from home, except for IT staff. Like it or not, they had to turn up at the university, to negotiate with vendors, and install and modify new hardware and software systems to cope with the COVID crisis. Above all, it was thanks to the hard work of IT staff that Japanese universities did not have to suspend their education and research activities during the pandemic.

Challenges that emerged during implementation

—What were the biggest difficulties or challenges that emerged?

KITA: It was all so hard that I can't recall what the most difficult things were (laughs). The biggest headache was probably dealing with part-time lecturers. The root of the issue was that the university system was never designed with part-time lecturers in mind. We couldn't link the ID information of part-time lecturers between academic affairs system and LMS. And part-time lecturers working at multiple schools had to conduct classes under a different system policy for each school. There were a lot of difficulties like these. Another concern for me was that many teachers seemed indifferent to how students were studying. Whereas teachers were able to

“**A top-down system to enable rapid decision-making worked well.**

(Suganuma)

*1

FD = faculty development, a generic term for systematic efforts by faculty staff to improve and enhance class content and methods. Specific examples include the implementation of mutual class observation by teachers, holding study groups on teaching methods, and holding training sessions for newly appointed faculty staff. (A summary from the Central Education Council's report "Future Vision of Japanese Higher Education," January 2005.)

“**The main reason why the COVID-19 pandemic did not force a stop to education and research was the hard work of IT department staff.**

(Fukazawa)

Future Directions from the Viewpoint of Educational Information Infrastructure

*2

On-premise: This means that servers, software, and other information systems are installed and operated within facilities managed by the user (university or company). Initial costs such as server procurement and maintenance costs are higher than using cloud services, but there is greater freedom to make necessary customizations.

“Although it is a system, human support is essential. The issues of IT infrastructure development costs are not yet widely understood.

(Takemura)

“The transformation that has been going on for decades has suddenly taken a great leap forward, under the “external” influence of COVID-19.

(Kita)

conduct their online classes with good equipment and technology, many students lacked reliable equipment, using only a notebook PC or smartphone. I get the feeling that there is still a lack of understanding about this situation.

SUGANUMA: In terms of infrastructure, we suffered overloads **on premise***2 that caused temporary system outages. These were reported extensively in the national news.

And like at other universities, our education-related systems were intertwined in complex ways, with different departments in charge of different parts of the system. Where is the information that students really need? Where are the bottlenecks that make the system heavy? And, in the final analysis, where do we need to make improvements? The biggest problem was that we couldn't see or grasp the big picture.

TAKEMURA: As I mentioned, although the system load at Osaka University was not so great, the human load was high. Although human resources on campus are shrinking, due to the shift to cloud computing, it was still necessary to provide for help desk services and other kinds of support from the same pool of personnel. One issue, for example, was that many teachers prepare for their classes on weekends, when support staff are unavailable, which means that all their email inquiries have to be handled by faculty staff. Things have gradually improved, because we made it clear that support is not available on weekends, but in the first few months, when teachers were very desperate, I had a hell of a time replying to their emails. Resources are also a cost issue. At Osaka University, LMS usage is 5 to 10 times higher than it was before COVID. With a commercial LMS, usage fees go up as the quantity of data in the LMS increases, so there is a question about how to bear those higher costs. In the field of facilities management, it's well known that maintenance costs are constant. In the realm of IT infrastructure, however, we don't seem to have a firm consensus about this yet.

FUKAZAWA: The biggest challenge I see is caring for students. We have a huge number of students at Waseda. Things are not so bad for those who live with their families locally, but those who relocated to Tokyo have had it tougher. Some had to give up their apartments and return home, while others stayed in their apartments, living in isolation. Taking care of such students, which involves their mental well-being, is still a big challenge. There are three overseas students in my lab, but due to COVID, I haven't met them face to face yet. I am supervising their research online, but I could end up awarding them a degree without ever having met them in person. I'm not sure that's a good thing.

The essential requirements of universities are changing

—What are your plans for the future?

KITA: It's amazing that this transformation, which has been going on for decades, has suddenly taken such a big leap forward, due to the impact of an "external" factor like COVID-19. It's also become very clear that it's not essential for universities to tie students and faculty staff to campuses. Given all this, what's the next step for universities? I see the need for a major shift in thinking.

SUGANUMA: Seeing that all the staff seemed very busy with their various duties, as head of the Cyberscience Center, I took on the task of lending out Wi-Fi equipment to students myself. Students who didn't know me from lab work or lectures probably looked on me as "that old clueless Wi-Fi guy." Still, the opportunity to listen directly to the opinions of students allowed me to get to know their reality. For example, many students faced poor connectivity when parents, siblings, or whole families were using the home Internet connection at the same time. And some students didn't even have a home broadband connection, forcing them to use the limited data available on their smartphone service plans. As the network manager of the Cyberscience Center, it seems painfully clear that to promote online classes more effectively, we need to consider the reality of the network connectivity available to students.

TAKEMURA: As Professor Kita mentioned, there has been some rapid change, but I truly believe that we are only at the beginning of a process. In the case of language and general math classes, many teachers still teach the same content. If we think about how to make best use of online education, we could create videos of the teachers who are the most skilled at preparing and delivering lectures and get students to watch them. Meanwhile, other teachers could check students who watch the video for their level of understanding, or support students unable to keep up with the class. In other words, digitalization makes it possible to implement education in a more fine-grained way, without any additional costs. Or else, on-demand and online content could be used to allow students to take "high-flex classes" that let them choose the optimal timing and study method for their schedule and physical condition. This would enable students to take classes that are held concurrently. Of course, clear rules would have to be established, but universities undoubtedly have the potential to develop a more flexible course system.

FUKAZAWA: We can summarize the situation with the phrase, "turning misfortune into good fortune." The COVID-19 crisis has changed many things for universities. Some changes were unavoidable, but others were conscious improvements. The important thing is to keep changing things for the better, not just to preserve the improvements when the pandemic ends, but also to build on and develop the improvements further.

“Students who didn't know me probably looked on me as “that old clueless Wi-Fi guy,” but I could get to know their reality.

(Suganuma)

“With “high-flex classes,” it would be possible for students to take courses that are scheduled concurrently.

(Takemura)

““Turning misfortune into good fortune” sums up the situation. The important thing is not only to preserve the improvements made due to COVID-19, but also to develop them further.

(Fukazawa)

"Even on Christmas Eve, we were in a meeting..."

As of January 2022, the "DX Symposium for Educational Institutions" had been held 45 times since this initiative was launched in March 2020. The symposiums could never have been held so frequently or for so long without the strenuous efforts made by the NII project staff. We spoke to some of the people who worked on the symposiums behind the scenes.

—What can you tell us about the beginnings of the symposium?

DOI (then working at NII): In March 2020, just before the state of emergency declaration, universities found themselves in a desperate situation because they had to somehow start running classes online. That's when NII Director Kitsuregawa urged us to show universities the way forward. NII had recently helped to organize the annual conference of the Database Society of Japan (DEIM2020) as an online event, using the video-conferencing tool Webex. Since that was a success, we anticipated a large number of people for the DX symposium. As we fretted over how to run the event, we were basically told to get the cooperation of the staff who worked on DEIM2020 and "just do it" (laughs). It was very much a trial-and-error process.

OKAMOTO: Initially, we ran the symposium once a week. We would have an executive meeting on Monday night, where the professors involved

in planning would decide a suitable program. We would then coordinate the presenters for the symposium on Tuesday and Wednesday. Then, after testing the connection on Thursday, we would run the online meeting on Friday. The process would start over again the following Monday. On Saturdays and Sundays, we would process survey results, edit video, and so on.

DOI: I had to work on the symposium on top of my usual duties. The professors were happy to know that the number of participants was growing rapidly, but I found the same news quite frightening. The number of people joining the meetings was so high that any difficulties would be a huge inconvenience for so many. That's why I had to put everything I had into making the symposium work.

—Were there any difficulties that were particularly memorable to you?

DOI: It would happen that the day before a symposium we hadn't yet decided on the presenters, or professors might be pressuring us to add speakers to the program, so things got very hectic.

OKAMOTO: In the early days, the symposiums were long, so we inserted some breaks. For a time, we played videos of *manzai* and *rakugo* (comic monologues and storytelling) during the breaks. The intention was to fill in the time because it was an online event. We were just sent the videos unannounced. "What the hell are we supposed to do with this?", we thought. But we got into the spirit and even added some music to the videos.

"I got into the spirit and added some musical accompaniment to the videos of *manzai* and *rakugo* (comic performances) played during breaks!"

Secretariat staff speak

Manager, Academic
Infrastructure Division, Cyber
Science Infrastructure
Development Department, NII
SATO, Suguru

Chiba University
Manager, Information Planning
Department, Planning and
General Affairs Division

DOI, Mitsuhiro



Past symposiums can be viewed at the “DX Symposium for Educational Institutions Archive.” To register for future symposiums, you can use the same link.



www.nii.ac.jp/event/other/decs (in Japanese)

"As soon as it ends, another project is sure to come along."

DOI: Indeed, everyone was strangely psyched up (laughs).

UEMURA: I was even further behind the scenes, responding to incoming email inquiries, so I didn't feel such intense pressure. Still, I got a lot of inquiries like, "I can't connect," or "I didn't get the auto-confirmation email when I registered," so I was doing my best to resolve all the issues.

NODA: I've been in charge of the symposium since April 2021. While Mr. Doi was in charge, the frequency was dropped to every two weeks, and then from October 2021, down to every three weeks, so I have more time to spare and things are much less difficult. However, I still need to deal with last-minute changes. Around the transition from 2021 to

2022, we hurriedly decided to try out VR for the symposium...

SATO: That was a real tightrope walk, wasn't it?

The connection test on the day didn't go well, and we only managed to get things working an hour before the start. The preparatory meeting started at 8:30 p.m. on a Friday. And it was Christmas Eve.

We want to broaden the appeal of the symposium.

—How do you see the future of the symposium?

OKAMOTO: We want to continue trying to reach a greater variety of people with the symposium. We also worked hard to make a video archive of the symposiums publically available; something that many survey respondents requested. I hope many people can make use of it.

SATO: On the management side, we seem to be short of resources. I have

requested more personnel, but my wish has not been granted as yet (laughs). I hope we can find ways to reduce the burden, to prevent everyone from collapsing.

NODA: My only wish is that every symposium ends without any serious issue. I hope we can go on running the symposiums without difficulties.

DOI: I initially thought the symposium would end after a couple of months, but it has continued until today. As far as I know, no other NII event has gone on continuously and so frequently for as long as two years.

UEMURA: Since a large part of the project is based on Director Kitsuregawa's interests and concerns, it will probably continue for a while yet.

OKAMOTO: Well, let's keep doing it energetically for many years to come!

NODA: As soon as it ends, another project is sure to come along.

DOI: Well said, Mr. Noda, with your typically philosophical outlook.

Interview/ Written by KAWABATA, Hideki

Manager, Coordination, Infrastructure
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UEMURA, Junichi

Chief URA,
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OKAMOTO, Yuko

Behind the Scenes of the “DX Symposium for Educational Institutions”

Deputy Manager, Academic
Infrastructure Division, Cyber Science
Infrastructure Development
Department, NII

NODA, Hideaki

Interview

An Investment Money Analysis System to Ensure Economic Security

Global investment money moves around the globe across complex networks. AI analysis of vast amounts of big data may enable effective investment. A leading researcher who has developed a system for visualizing financial information looks at the reality of investment money and the ideal form of investment that we should be aiming at.

—What led you to analyze stock investment networks based on informatics?

The worldwide easing of monetary policy due to the COVID-19 pandemic has given rise to a flood of investment money. Even in Japan, individual investment has grown dramatically. A single mutual fund might include stocks from 100 or 1,000 companies across the world. The stocks are also frequently changed.

In recent years, the concept of “ESG investing”—investing only in socially responsible companies—has become widespread. However, it is quite likely that money invested in mutual funds ends up with companies that engage in the very opposite of ESG.

Thanks to informatics, we can freely invest in companies all over the world using nothing more than a smartphone. Even as we speak of a Society 5.0 future, the fact is that investment networks are now so complex that no one is capable of tracking them. That’s why I thought that we needed to use informatics to study them and why I started developing this network analysis technology.

—Did you encounter any technical issues when developing the new analysis system?

When you look at investment networks from an informatics perspective, the biggest challenge is that they are nonlinear phenomena.

Suppose that three parties own 45%, 40%, and 15%, respectively, of a certain stock. Although profits are distributed in the ratio of 45:40:15, management rights are determined by who allies with whom, because nobody has a majority stake. In other words, rights are distributed in the ratio of 1:1:1 because any of the three parties could end up with the deciding vote. It is also increasingly difficult to see who has what influence where, because of the complex interconnections between parent companies, subsidiaries, and affiliates.

To analyze this nonlinear phenomenon analysis, I made use of the concept of the Shapley-Shubik Power Index, which emerged in the field of political science in the 1970s. This index allows calculating how much influence (i.e., voting power) multiple parties have.



Over 90% of investment goes into “brown companies”

Although this index can be used to predict influence in a single company, with multi-layered networks it leads to a “combinatorial explosion.” I therefore developed an algorithm that approximates this index and propagates it to multiple levels.

—What aspects of stock investment networks did your analysis help to visualize?

One aspect, which relates to my

Unfortunately, Japanese investment money has a remarkably weak presence in the market.

MIZUNO, Takayuki

Associate Professor, Information and Society Research Division, NII



motivation for developing the system, is the ability to visualize where investment money ends up. When I traced the flows of investment money around the world, I found that in over 90% of cases, the money ended up in “brown companies,” whose activities do not necessarily conform to ESG values, or in industries such as gambling, drugs, and arms manufacturing.

The other aspect is making it possible to clearly distinguish between countries that skillfully control their

investments in a strategic sense and those that do not. Unfortunately, Japan as a whole and Japanese investment institutions lag behind in this area. Relative to the amount of money they have invested, they have a remarkably weak presence in the stock market. The fact that “we are putting in money but we don’t have or can’t have a correspondingly strong voice” means that we don’t have control over what the money we invest in is used for. Or in other words, that we are not fulfilling our social responsibility.

The responsibility of informatics

As I said earlier, the influence of investors is not necessarily proportional to the number of shares they own. If you invest skillfully, you can hold the deciding vote even with a relatively small stockholding.

If this analysis is applied effectively, it could be useful in making various kinds of investment decisions. For example, if you put in money but don’t get any say in a company, you should pull out of the investment. Or conversely, if it is possible to hold a deciding vote by investing

a relatively small amount of money, then you should actively go ahead with the investment.

If we can clearly define the point at which a deciding vote is obtainable, the method could be used to enhance economic security by protecting nationally important industries from hostile investment. Although the global stock market can be useful in accessing investment funds from around the world to help nurture industrial development, it becomes totally pointless if you end up losing control over companies or industries.

Although informatics has always had deep ties with economics, it has never really been used to tackle problems of ethics or security. I believe that along with making our world more convenient, informatics has a certain responsibility.

My research is still a work in progress with numerous issues that need to be resolved. It still takes too long to compute nonlinear propagations, for example. But I am continually incorporating new technologies and making improvements.

Interview/Written by KAWABATA, Hideki

Technical Challenges for Next-generation Mobile Networks

Supporting a “with/post COVID” society

KANEKO, Megumi

Associate Professor, Information Systems Architecture
Science Research Division, NII

Existing wireless communication systems face many challenges due to the rapid growth in mobile data use.

The numbers of mobile communication system users and IoT devices was growing exponentially even before COVID-19, but the pandemic has served to further accelerate the growth.

Since most of the low-frequency band (≤ 6 GHz) suitable for wireless communications is already used by existing systems, there is a serious shortage of wireless resources. The rapid rise in the number of users and devices simultaneously operating on the same frequencies across different wireless systems and cells is causing frequent interference and packet collisions, significantly degrading communication characteristics.

The newest wireless communication standard, 5G, was rolled out in 2020. Whereas standards up to 4G focused primarily on increasing transmission speeds, 5G was designed for other improvements too, such as lower latency, higher reliability, the ability to connect many IoT devices, higher system capacity, and lower power consumption.

The level of future technologies required for next-generation Beyond 5G and 6G networks greatly surpasses that of 5G. For example, Beyond 5G is expected to provide 100 times higher transmission speed and one-fifth the latency of 5G.

Even after the COVID-19 pandemic passes, there will still be a need for remote work. Online education, telemedicine, and remote care for Japan's rapidly aging society will also be vital technologies. As the “with/post COVID” era approaches, the bandwidth is-

sue mentioned above will become more urgent and the need for solutions will be more pressing.

Notable themes

Simultaneous improvements in the performance of various wireless communication parameters and power efficiency
IoT multi-network connectivity
Use of AI technology and mathematical optimization

To address the issue, Assoc. Prof. KANEKO, Megumi of NII is pursuing research on three key themes.

The first study aims to improve the efficiency of wireless resource utilization by taking advantage of cloud and edge functions. This research focuses on the power efficiency of mobile edge computing (MEC) and fog radio access networks. An interference control method that balances the centralized functionality of the cloud with the distributed functionality of each edge node was designed to increase energy efficiency, even when the wireless communication path is uncertain, while simultaneously improving latency and

inter-user fairness.

The second focus of study is the design of a wireless communication protocol for a power-saving wide-area IoT system. Conventional LoRa (long range) communication methods are subject to problems such as very low transmission speeds and substantial deterioration in characteristics with large numbers of connections. To address this, Kaneko succeeded in conducting a theoretical analysis of LoRa transmission speed under conditions of severe interference. She has proposed a method for optimizing LoRa resource allocation that simultaneously improves multiple performance indicators, including the number of connectable IoT devices, transmission speed, fairness, and power consumption.

The third research topic is wireless communication control that combines AI functions (machine learning) and mathematical optimization. A deep reinforcement learning method that utilizes the AI function of each user device to improve wireless networks with multiple base stations and users and a dynamically changing interference environment is proposed to enable effective utilization of the low-frequency band (sub-6 GHz) and high-frequency band (millimeter-wave band) for an entire system, simultaneously improving the rate and delay of each user in higher-density environments.

Further challenges

A next-generation mobile network to overcome the effects of the COVID-19 crisis

To a large degree, these studies have been conducted in collaboration with various domestic and overseas institutions, but the pandemic has significantly hindered international joint research and exchanges.

To continue top-level international research, it is necessary to bring in outstanding students and other personnel from abroad as soon as possible. To support a “with/post COVID” society and sustain international exchange and joint research, the construction of a next-generation mobile network like the one mentioned above is vital.

Interview/Written by KAWABATA, Hideki

Photography by IMAMURA, Takuma



The Search for the Shape of Virtual Space Continues

From the trenches of online academic conferences

IKEHATA, Satoshi

Assistant Professor, Digital Content and Media Sciences
Research Division, NII

As a result of the COVID-19 pandemic, many scientific conferences are now being held online. In this article, I would like to share my personal views about holding academic conferences online.

To begin, let me list some of the advantages of online meetings. The first one is that no physical travel is needed. Secondly, the participation fees for online academic conferences are typically lower than for offline events. The third benefit is that there are fewer time constraints. At offline conferences, there are often multiple sessions running concurrently, whereas online, it is easy to move between sessions. Furthermore, the presentations are often recorded, so they can be viewed at any time. The ability to attend academic conferences anywhere in the world with unprecedented ease is undoubtedly an advantage.

Useful approaches

New event tools lower psychological barriers

What about the downsides, though? Academic conferences usually have both oral presentations and poster sessions, but it is the latter that are most seriously impacted. Since the pandemic began, I have attended several academic conferences. Initially, the typical format was that each paper was assigned a separate virtual “room,” inside of which discussions were held. In some cases, there was direct conversation, for example with videoconferencing; in other cases,

communication was only possible by text. In any case, this format has never worked successfully in my experience. Since you cannot see what is inside a “presentation booth,” there is a high psychological barrier to entering. Most of the participants soon stop listening to presentations they are not very interested in. As a result, the overall mood of the event is unexciting.

After repeated experiences of this nature, some academic societies tried to come up with different ways of running poster sessions. Some of these innovations failed. One of the regrettable things I saw was that participants could tell how many people were in each room before entering. The expectation was that knowing that someone was already in a room would lower the psychological barrier to entry. Ultimately, though, this idea failed to solve the problem of people not entering rooms for presentations they had little interest in.

On the bright side, I felt that one useful

approach was the use of online event tools. This was an attempt to simulate a poster session by placing multiple posters in a single virtual space. The biggest advantage is that it encourages similar behavior to real-world poster sessions, in the sense that people more easily view posters that they did not originally intend to look at, thinking, “Others are here, so let me take a look.”

The functions of online event services like SpatialChat and Gather seem to be getting more sophisticated all the time.

Still, even with these improvements, it is hard not to feel a sense of inadequacy. Ultimately, I have realized through online conferences how much value traditional offline conferences offer, in allowing opportunities to renew old relationships with friends and acquaintances, and even just the chance to travel to various places.

Problem statement

Simply reproducing some functions cannot substitute for the real thing

These experiences at academic conferences also prompted some reflections about virtual spaces.

The author is currently involved in a project titled “Creation of Digital Twin Space for Virtual Exploration via 360-degree Video” in collaboration with the research lab of AIZAWA, Kiyoharu at The University of Tokyo, under the Japan Science and Technology Agency’s (JST) Mirai Program. This project shares the same basic goal as online academic conferences: to reproduce a real space virtually.

However, if the same logic applies, then it would seem impossible to deliver a satisfactory substitute for reality by simply reproducing some functions. Perhaps the sense of reality lies in apparently unnecessary “extras.” I feel that this gives rise to an important question about the nature of virtual space.



NII NEWS TOPICS

Period

November 25 (Thu.), 2021 to
February 14 (Mon.), 2022

More details about news items
are available online.

www.nii.ac.jp/news/2021



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Bit (NII Character)



NEWS RELEASE

2022

Feb. 14

Promoting R&D on 5G data offloading using next-generation public wireless network technology (Passpoint)

—A new research project commissioned in FY2021 as part of NICT's "Beyond 5G R&D Promotion Project" commences

Jan. 14

NII starts making medical datasets of Japan System Techniques available to academic researchers

AWARD

2022

Jan. 28

Prof. KITAMOTO, Asanobu (Digital Content and Media Sciences Research Division, Center for Open Data in the Humanities) and colleagues [win Best Paper Award at JINMONCOM 2021](#)

2021

Dec. 24

Assoc. Prof. INAMURA, Tetsuya (Principles of Informatics Research Division), Ms. TAKAHASHI, Nanami (NII Research Assistant), and Mr. NAGATA, Kohei (NII Research Assistant) [win an Outstanding Presentation Award at the 22nd SICE Lecture Meeting on System Integration](#)

Dec. 24

Assoc. Prof. INAMURA, Tetsuya (Principles of Informatics Research Division), Mr. IWAMI, Koichi (NII Technical Assistant) [win an Outstanding Presentation Award at the 22nd SICE Lecture Meeting on System Integration](#)

Dec. 8

Assist. Prof. AOKI, Shunsuke (Information Systems Architecture Science Research Division) [wins Kenjiro Takayanagi Foundation Encouragement Award 2021](#)

Nov. 25

Assist. Prof. IGARASHI, Ayumi (Principles of Informatics Research Division) is selected as one of MIT Technology Review's ["Innovators Under 35 Japan 2021"](#)



NII Open House 2022

NII Open House is an annual event, open to all, that gives NII the opportunity to present its research findings to the public.

The program and other details will be posted on the website as soon as they are decided.

- Keynote speech
- Poster sessions by researchers and more

Dates:

**Jun.3(Friday),
Jun.4(Saturday)**

www.nii.ac.jp/openhouse/

INFORMATION

2022

- Jan. 31** “RIKEN Short Answer Scoring Data Set” is updated
- Jan. 28** NII 2021 Public Lecture No. 5: “What Does It Mean to Understand the Meaning of Words?—Developing and assessing AI for understanding language” (Assist. Prof. SUGAWARA, Saku) is released
- Jan. 20** NII FY2021 Overview is published in English
- Jan. 14** NII starts making medical datasets of Japan System Techniques available to academic researchers
- Jan. 12** PR magazine “NII Today” No. 93 “Kashiwa Annex, a New Knowledge Hub” is published
- 2021**
- Dec. 6** NII 2021 Public Lecture No. 3: “Making the World Fair with Algorithms?—From dividing up cakes to sharing housework” (Assist. Prof. IGARASHI, Ayumi) is released

EVENT

▶ www.nii.ac.jp/news/2021

- **Feb. 22, 2022:** SPARC Japan Seminar 2021
“What is the Aim of Research Data Policy?”
- Cyber Symposium on Online Education and Digital Transformation in Universities and Other Institutions
“DX Symposium for Educational Institutions”
Mar. 4, 2022: Online Symposium No. 47 (with metaverse lecture)
Feb. 4, 2022: Online Symposium No. 46 (with metaverse lecture)
Jan. 14, 2022: Online Symposium No. 45 (with metaverse lecture)
Dec. 10, 2021: Online Symposium No. 44
- NII 2021 public lecture series “Frontiers of Informatics” has commenced!
No. 1: “Searching for Hidden Regularities in Data!—Pattern structures and AI” by SUGIYAMA, Mahito
No. 2: “How to Evaluate the Reliability of AI Products—The wonders of AI and the difficulties of AI as a product” by ISHIKAWA, Fuyuki
No. 3: (for high school students) “Making the World Fair with Algorithms?—From dividing up cakes to sharing housework” by IGARASHI, Ayumi
No. 4: “Who Owns Academic Information?—A future society created by everyone through open science!” by FUNAMORI, Miho
No. 5: (for high school students) “What Does It Mean to Understand the Meaning of Words?—Developing and assessing AI for understanding language” SUGAWARA, Saku
No. 6: “Food and Mood - Any relationship? Towards data science” by ANDRES, Frederick (with Japanese translation)

COLUMN

Metaverse space symposium held in collaboration

with The University of Tokyo's VR Center

The 45th DX Symposium for Educational Institutions, discussed on page 8, was held in the metaverse, in collaboration with The University of Tokyo Virtual Reality Educational Research Center (VR Center). In addition to streaming video using the usual platforms (Webex Events, YouTube Live, and LINE LIVE), a virtual space was set up using cluster (lecture hall) and Hubs Cloud (participant viewing space). FUJII, Teruo, president of The University of Tokyo, appeared as a 3D avatar to deliver a lecture titled “Into a Sea of Diversity: Creating the Future through Dialogue” in a cluster representing the deep sea. The lecture was followed by presentations by two students who are active in the field of public health. They engaged in dialogue with the president in the metaverse space. VR Center director AIZAWA, Kiyoharu then offered a behind-the-scenes look at the VR lecture.

Participants entered the Hubs Cloud viewing space operated by the VR Center to view the lecture, which was projected on a screen in the VR venue. Mozilla Hubs and its cloud version, Hubs Cloud, can be run in a browser on a PC or smartphone, without the need to install any add-ons. The prepared viewing space was set up to enable viewing of lectures delivered via cluster or Webex.



Lecture hall representing the deep sea (cluster)



UTokyo president FUJII, Teruo and students engage in a dialogue in the metaverse.



NII Today No.94
Detailed articles are
available on our website.
(In Japanese)

[Essay]

A New Normal for the Next Generation, Due to COVID-19

— Uncertainties and expectations

Now that I think of it, it's two years that I've been working from home to help prevent COVID-19 infections.

As the months roll on, I maintain a faint hope that with a little more endurance we can get back to living like we did before the pandemic. Every time I remember that the pandemic has gone on for two years, I'm surprised anew. Just the other day it seems, I was talking with a colleague at NII that I hadn't seen for ages. We decided that we would go out for a drink as soon as the COVID situation settled down. But actually, that was more than a year ago.

For adults, who are accustomed to repetitive daily routines, a year often seems to pass like the blink of an eye. Things are different with children, however. Since they are in the most impressionable stage of life and their days filled with a succession of fresh experiences, the past two years have probably had a much more profound impact on them. They might not even understand what it means when adults talk of life returning to normal. After these two years of pandemic, a new era has already begun for children. And from what they are experiencing now, a new "common sense" will emerge. Thus, when all the children who were at school during the COVID-19 crisis enter the workplace,



"back to normal" will no longer make any sense, because the world will have changed more than today's adults can imagine.

In these two years, Internet-based learning environments everywhere have been enhanced. Online classes are now widely offered, not only at universities and other higher education institutions but also at elementary and secondary schools. Elementary schools are making use of tablets for online classes as electronic textbooks, and they are even teaching kids the basics of programming.

Since the pandemic started, there has also been an explosion in content and in participation in massive open online courses (MOOCs), along with more educational videos on YouTube

and online learning environments for working people. This means that online learning environments have rapidly become familiar to all generations. At the same time, more and more learning history data are being accumulated from various devices. And the use of such data to provide educational support (learning analytics) is likely to expand in the coming years.

Given this trend, how can recent initiatives such as the SDGs, digital transformation (DX) of education, and learning analytics take root in the next generation? What will this transformed world look like? Perhaps, as online learning environments become more and more powerful, many online learning materials that required enormous amounts of time, money, and effort to create will be casually stored away on the Internet or just vanish into thin air. In addition, people who cannot adapt to next-generation learning environments may end up as victims—an informationally deprived social class. On the other hand, what I hope to see in the new era is the employment of learning analytics to facilitate the reuse and improvement of educational resources, and the design of optimized teaching materials and learning support to ensure that nobody, of any age, is left behind. I will, of course, be trying to do what I can to help realize this vision.

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into Knowledge

NII

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