Building on Cultural Capacity for Innovation Through International Collaboration: In Memory of Naomi Miyake

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Abstract: This symposium addresses issues of scaling up research-based educational reforms, with focus on the Japanese Knowledge Constructive Jigsaw initiative--a substantial achievement of Naomi Miyake and learning science colleagues in Japan. Scaling up procedures involve small networks of teachers, education leaders and researchers working together to design, practice, and improve lessons across subjects, schools and districts. The set of strategies developed provides a common Knowledge Constructive Jigsaw framework or set of "*constraints*" to guide the practices of participants for reflection on learning and to expand children's potential to learn, teachers' potential to support student learning, and policy makers' potential to support teacher learning. Building Cultural Capacity for Innovation represents a vision shared by teams in Japan and internationally to transform schools into knowledge creating organizations, to learn from one another, and to—in Naomi's words--support a science of practice deeply embedded in the learning sciences.

Keywords: scaling-up, knowledge constructive jigsaw, knowledge building, DBIR

Introduction

This symposium is dedicated to Naomi Miyake, the former president of ISLS, who passed away May 2015. Miyake asserted and demonstrated that every child has the potential to engage in constructive interaction in order to learn deeply and find newer questions to explore (Miyake, 2013a). The symposium focuses on the Knowledge Constructive Jigsaw project led by Naomi in Japan—an initiative that has made significant advances in scaling up educational reform by building on cultural capacity for innovation and international collaboration. Knowledge Building International (KBI) members and KBI President, Marlene Scardamalia, worked with Naomi to realize a shared vision, as Naomi's ideas have many commonalties with Knowledge Building and "Building Cultural Capacity for Innovation (BCCI)" (Scardamalia & Bereiter, 2014). Complementary initiatives include transforming learning from more traditional, teacher-centric, didactic practice into future-oriented, learner-centric, knowledge constructive/creative practice, using a more insightful understanding of how people learn. If we can transform the concept of learning, we can empower all learners including students, teachers, school leaders and educational policy makers to build cultural capacity for innovation through educational reform. The question is how to turn the concept of BCCI into a reality in everyday practice through a "science of practice" (Miyake, 2015) deeply embedded in the learning sciences. Developing Naomi's ideas, we assume that every human has potential capacity for innovation and every culture innovative capacity through collaboration among its participants. Therefore, we named this symposium, "Building 'on' Cultural Capacity for Innovation" which declares that we can build upon existing but unseen capacity for innovation. The next-level question is how to build upon, or *draw out*, such capacity, which is the overall focus of this symposium.

Theory of "how people learn" as the core of educational reforms

Learning sciences have not made much impact on educational practices in Japan, in spite of innovations in learning theories and technologies (Law *et al.*, 2013; Penuel & Spillane, 2014). There is an unfortunate divide between cutting-edge works by learning scientists and large-scale educational reforms by researchers of educational systems and management, the latter of which do not take full advantage of the innovations. There is another unfortunate divide between teachers who make local innovations of "know-how" and educational researchers who cannot create nor implement learner-centric lessons, yet espouse *unfounded* theories or "know-why." Such researchers often give lectures to the teachers, direct them, and end up being distrusted. In order to change these situations, we need to restore the theory of "how people learn" as the core of educational reforms at every level from the classroom level to the policymaking level, and "craft coherence" of learner-centered, collaborative

knowledge construction among all members including students, teachers, school leaders, researchers, policy makers and stakeholders from the business sector. At this symposium, we will focus on the Japanese project to reform public education led by Miyake, which is rapidly being scaled up and has gained steady success. We will scrutinize both the key factors that promote project sustainability and scalability and those that hinder them, with the help of international collaboration.

Integrative points illustrated through collective works

In 2009, the University of Tokyo launched an initiative, the Consortium for Renovating Education of the Future (henceforth CoREF; http://coref.u-tokyo.ac.jp/), strongly grounded in the learning sciences in order to contribute to renovating Japanese education with two important strategic orientations. One is to bring university research closer to the policy makers at the ministry of education (MEXT) and the boards of education throughout Japan, so that university-level scientific knowledge has a better chance to become integrated in their curricula and to encourage scientifically-minded young learners. The other is to base such renovation on talks between the universities and the business sector, so that educational reform can be supported by society as a whole.

This project is one of the rare cases where the learning sciences have been adopted in earnest to guide renovation in classroom practices, using a concrete framework, "Knowledge Constructive Jigsaw" method (hereafter KCJ), with the joint efforts of the regional boards of education. This initiative is also unique in spanning all subject areas taught at all school levels, including elementary (1st to 6th grades), junior high (7th to 9th), and high schools (10th to 12th) across Japan, because the framework is not bound to the specific contents or practices of any subject. As a result, the participating teachers as well as the administrative leaders at the school and board of education levels are learning the sciences of how people learn, not in abstract forms but through implementing them in the actual classroom. In the following, Saito & Shirouzu (Paper 1) will illustrate the underlying theory, practice and assessment of KCJ with its preliminary outcomes. As a participating teacher, Ogawa (Paper 2) will report on her own version of "how students learn" through eight-year experience of KCJ in high school ESL classrooms. In order to help these teachers, Iikubo & Hori (Paper 3) will explain various implementation strategies that CoREF has been employing, especially forming networks of small networks (hereafter, NNs) of education leaders, experienced as well as novice teachers, to work together to design, practice and reflect lessons for the transformative evaluation, across subjects, schools and districts.

The significance of the contributions

This symposium will contribute to clarifying how to go beyond the hidden, negative factors of scaling-up. The biggest challenge for the CoREF project has been a fixed and uniformity-oriented mindset that has been absorbed by many students, teachers, school leaders and policy makers. One achievement in the reform history of Japanese education is the setting of clear standards for every school to make sure that the school can provide high quality education for every child. While this has been successful, we now also realize that this approach does not allow for sustainability and creativity, features which are crucial for the young today to make better worlds. Education needs to be changed from one that guides the students to achieve a set goal through a uniform process into one that helps every student go beyond such goals through her or his own process.

The first strategy that CoREF has adopted is the development of a new, concrete method of practice, KCJ, which has improved the individual progress of students who were not regarded to be "good" students but who were able to strive and perform at higher levels through constructive interactions. CoREF's assessment tools assess each individual's process of learning at short intervals and a lot more often, not through one-off answers to a set of test questions and/or interviews. This would make "formative evaluation" truly "formative" and "diversity" of learning outcomes clear. Coupled with the second strategy of forming NNs to appreciate and discuss such diversity, or *individuality*, the goal of the CoREF project is to foster the learning of individual learners, practitioners, researchers as well as society, together as a community of independent "learners." KCJ aims to draw out not only the children's potential to learn but also the teacher's potential to re/design lessons and understand children, as well as the educational policy maker's potential to re/design the support system for teachers. KCJ could be considered as "constraints" (Norman, 2013), by which we mean common elements that guide the practices of participants at every level for collaborative reflection on learning.

Key issues and contrasting scaling-up approaches

At a glance, the CoREF approach emphasizes the concrete images and know-how of collaborative learning. On the other hand, the Knowledge Building project emphasizes a principles-based rather than procedure-based approach for scaling up (Scardamalia & Bereiter, 2006), leaving "know-how" as a design challenge. These two projects therefore provide a fascinating contrast in approaches for scaling up, with different systems of *constraints.* Differences as well as shared visions have led over the years to intense conversations between KCJ and

Knowledge Building colleagues, as well as visits to each other's sites of innovation. The CoREF members now see constraints as lenses of the cognitive and learning sciences that effectively collect the high-quality, constrained data of learning processes, and provide an arena for collaborative reflection on learning. The constraints also can make the diversity of participants' mindsets of learning more explicit because participants base their discussions on a common foundation.

Building Cultural Capacity for Innovation

Marlene Scardamalia

"Building Cultural Capacity for Innovation" (shortened to "BCCI") is an international design, research, and development initiative to build cultural capacity for innovation in developing and developed nations, at all educational and socioeconomic levels. International partners are united by the idea that large increases in a society's innovativeness require building capacity for it, starting in early childhood, aimed at democratizing knowledge creation, and continuing through progressive development toward adult life and work in knowledge-based societies. BCCI is a research-intensive enterprise dedicated to the 21st-century principles of a place for everyone and knowledge for public good. BCCI research not only tests but creates innovations. Within the Knowledge Building context, the goal has been to create internationally distributed teams of innovators to support the spread of research-based innovations through global collaborative innovation networks. As suggested above, Knowledge Building represents a different scaling-up model with a different system of constraints from that used by KCJ. Naomi and Marlene spent many hours discussing different approaches as well as shared visions. Marlene will convey how they got from their different paths to a shared commitment to Building Cultural Capacity for Innovation.

Theory, practice and assessment of Knowledge Constructive Jigsaw

Moegi Saito and Hajime Shirouzu

CoREF has been working with the prefectural and city/town boards of education to develop learner-centric teaching curricula using KCJ. In Year 2015 (April 1, 2015 to March 31, 2016), this project is working with 184 core schools, 1136 core teachers and education leaders from 21 boards of education. Table 1 shows the scale of the project up until Year 2014. Teachers from elementary, junior-high and senior-high (officially from 2012) schools participated in the on-the-job training (OJT) workshops run by CoREF. All participants attempted some collaborative class teaching according to our guidelines and framework. The "core teachers" made select cases open online to be used for the purpose of lesson studies. Among such cases published online were 711 class practices complete with teaching plans, learning materials, students' performance records and a class video, which help provide next-generation participants with reference cases to kick-start their own trials.

Table 1: Number of participating parties and class practices by year

	2010	**2011**	**2012**	**2013**	**2014**
Parties *(Ed. board members)*	10 (15)	20 (27)	17 (92)	18 (73)	19 (122)
Core Schools *(teachers)*	23 (39)	70 (122)	125 (477)	152 (608)	189 (712)
Class practices on the CoREF site	35	102	121	179	274
Created in the OJT training	0	0	563	706	688

Three-level model of conceptual change and theory of constructive interaction

Cognitive studies on conceptual change have contributed to refine distinctions between naïve, everyday construction of knowledge and the construction of more scientific concepts. Miyake (2013b) proposed a three-level model of what kind of concept is acquired and how. The learning of concepts at Level 1 utilizes personal experiences. When a child "forms" a concept by experiencing one instance of some phenomenon, learning on Level 1 is said to have started. If the same child integrates his or her experiences of repeated encounters with similar incidents, he or she will be able to integrate them into a rule of thumb of Level 1. When the same individual is introduced to the concepts of others and/or more "scientific" concepts through media or at school, Level 2 and Level 3 learning starts. At Level 3, learners are required to learn scientific, state-of-the-art concepts in adaptive ways. There is usually a wide gap between the understandings of Levels 1 and 3, which often causes difficulty in school learning. The model provides as an intermediate level of Level 2, where the learner is expected to engage in repeated, rich collaborative learning experiences to modify the Level 1 understanding in various forms, so that

the learner is able to integrate them for the purpose of abstraction, to reach the Level 3 understanding. This is the reason why collaborative learning including KCJ is needed in school learning.

The question is raised as to why collaboration is thought to contribute to such abstraction. Miyake proposed the theory of "constructive interaction" which states that two persons, when engaged in solving a shared problem, exchange the roles of a task-doer who proposes possible solutions and a monitor who reflects upon such proposals. Such role exchange potentially promotes each participating individual's understanding of the problem, and eventually leads her/him to arrive at their own solution (Miyake, 2013b).

Framework of the Knowledge Constructive Jigsaw and its outcomes

The KCJ consists of five learning activities: (1) writing an answer to the day's given problem based on his or her rule of thumb, (2) an expert-group activity which allows each individual student to accumulate some pieces of knowledge relevant in solving the problem, (3) a jigsaw-type activity where students from different expert groups get together to exchange and integrate the accumulated pieces of relevant knowledge and form an answer, (4) a cross talk activity to exchange their ideas for solutions, involving the entire class, and (5) writing down his or her own answer again to the same problem and newer questions. This is a strongly scripted yet dynamically modifiable collaborative learning framework, developed from the Jigsaw method (Aronson, 1978) emphasizing the role of the shared "problem" for knowledge construction. The design naturally requires each student to become a task-doer in the jigsaw group, and provides each student with the chance to become a monitor who infers what the other students say and why they say that, in order to integrate the ideas of others with their own.

Concerning content achievements of KCJ, a comparison of the two answers given at the beginning and at the end of the class constantly shows the progress and depth of learning. Also, the content achievement levels of the KCJ classes measured with traditional tests tend to be high: for example, 60% out of more than 900 initial high school teachers who participated our OJT reported that they were higher than those of the regular classes.

In addition to the content achievement, we have assessed a new set of goals to be (1) portability, (2) dependability and (3) sustainability. The outcomes of learning have to be "portable" in the sense of being taken out by the owner in new situations; "dependable" in the sense of being usable in adaptive ways by the owner to identify and solve new problems; and "sustainable" in the sense of letting the owner ask new questions, become motivated to learn further and integrate them with new pieces of information for the creation of innovative ideas.

The portability of KCJ learning outcomes has been reported as high, even after six months to one year later (see Paper 2). For example, a science teacher at grade 4 posed the question of why a heated can collapses when cooled suddenly, to which 90% of the 30 pupils did not only answer correctly at the end of the class by integrating information they had gained through three experiments (cooling of a bag full of vapor; heating and cooling of a bottle of milk with a balloon on its top; cooling of a heated conical flask with a boiled egg on its top), but were also able to recreate their explanation one and a half months later. More than half of the pupils forgot to which experiment they had been assigned, indicating that the information was integrated as a "whole."

The dependability of KCJ learning outcomes is indicated by high performance on transfer problems and students' spontaneous mentioning of the outcomes on different units and subjects. When the science teacher mentioned above broke the boiled egg in pieces to take it out from the flask after the lesson, several students got together to ask, "Why can't we take it out without breaking it?" and proposed several ideas. A high-school history teacher reported that after teaching several units of European history by KCJ, his students developed the willingness to look into the complex, intricate dynamics behind the newly introduced "historical event," such as "Okay, so who was involved in what kind of roles? This thing cannot be explained by one cause, of course."

As the sustainability of KCJ outcomes, teachers appreciate students' desire to learn and ask questions. Students tend to increase the amount of "spontaneous homework," which is not assigned by the teacher, but they wish to extend his or her studies. Also when the scheduled class period ends before the intended activities are completed, the students kept working on the task during their lunch period or after school, often coming back to the next class with new, developed answers. Students also generate their own "next challenges," or advanced questions. After learning that a leaf of a tree looks green because it does not use the green spectrum of light for photonic synthesis, high school students asked, "Do the leaves of seaweed look brown because they need all the spectra of light?" or "Do the colored leaves stop photonic synthesis?" As another example, after learning how clouds in the sky are made, a junior high school student asked why water changes its state from liquid to gas at 100 degrees Celsius, and how common such a change of state is with materials on the earth.

Assessment tools for future

All the outcomes above came from the teachers' continuous improvement of their lessons, which is rare in an intensity of this scale in Japan. Next, why had the CoREF project been able to make differences to teacher learning? The first reason is the adaptability of the KCJ framework in the sense that the "problem (jigsaw task)"

and "learning materials (for the expert activity)" are decided by each teacher. The second reason is that the essential flow of activity allows constructive interaction to take place naturally and repeatedly. The last reason is that the assessment tools utilizing such observation chances can "visualize" the students' learning processes.

The first tool is "comparison of pre and post class comprehension," which simply asks the same question twice. Thanks to this, children can compare their own answers, and confirm whether they have seen progress, or *idea improvement*. Teachers can also compare the answers with their expectations, and ascertain to what extent children have deepened their understanding and how diverse their progressions and expressions are. The second tool is "multilateral dialogue analysis," which aims to auto-transcribe the students' conversations in all of the groups during the class and provide transcripts electronically searchable by keywords. The analyses showed students' trajectories to range from exploratory talk to elaboration of justification of their own judgment, as expected from the three-level model of conceptual change. Also, in the preliminary trials using the system for teachers, they said "We want to assess these conversations!" and "We can tell what kinds of interactions were taking place by looking for transitional expressions such as 'Why?' 'Huh' and 'I see'." In this way, by making formative assessments a matter of everyday practice, we aim to help teachers trace children's change in a very concrete knowledge space and raise the quality of education through continuous improvement of their lessons. This improvement makes us believe that every child has the potential to learn, and even when they fail, not children but designs of learning environments matter, which we can improve endlessly as a whole society.

Knowledge Constructive Jigsaw in order to acquire a communicative knowledge base in high school ESL classrooms

Sonoko Ogawa

Student learning in KCJ classes

Japanese ESL has a reputation of not being all that successful in promoting communicative skills in everyday life. The Knowledge Constructive Jigsaw can enhance the students' spontaneous use of English for practical purposes, including learning new pieces of information from various reading materials, and evaluating and integrating them to form an answer to the given problem of the class. Here I will give a report on student and teacher learning gained through experiences of introduction of KCJ to high school ESL classrooms.

We have implemented KCJ classes using such questions as "Why is there a 'standard' in the world?" or "How should you reply when you are asked by a friend to lend him/her your car key when he or she does not possess a driver's license?" We have analyzed the data of the students' notes, memos and conversations recorded during the class, decoded and analyzed after classes in cooperation of CoREF. The results revealed that the students gradually increased the expressive richness of their English writings and utterances, particularly when they were encouraged to compare and structure the piece-meal materials contributed by themselves as well as by other members of the class. To illustrate these findings, let me report on a reading lesson taught by the author for 11th graders, the day's theme of which was "why we need a standard".

The group of students studied are at the age of 16 to 17 at a highly academic all boy's school. The students were asked to write their initial answers to the question: "Why do we need a calendar?" In spite of their generally high performance in the national standardized testing and at least four years of experience of ESL learning, only 7 out of the 32 students could write anything at all at the beginning of the class. In addition, even among the students who could write grammatically correct answers, the answers were often very simple and superficial as shown in Table 2. What they wrote was basically defined by "what they had experienced in English writing lessons." On the contrary, when they answered the same question at the end of the KCJ class, all of them were able to write something as their "answers." They showed progress both in content and grammar.

In the expert-group activity, students read one short excerpt on the main idea – what a "standard is," or how it works – written in English. Then, students engaged in the jigsaw activity, talking about their ideas both in English and Japanese and gradually forming their own ideas about "standards," and were encouraged to express the idea in English at the end of the class. We can see how exactly they developed their ideas and refined their English from the recordings as shown in the excerpt below. Through this set of collaborative activities to construct an integrated answer to one target problem, students changed their concepts relating to the problem into more sophisticated ones, each in their own way. They also became accustomed to some useful English expressions to deliver their newly constructed ideas through these activities. It was a new experience for them to be able to express what they have just thought for themselves in a foreign language. This type of conceptual work, we hypothesized, should stay in longer-memory than a usual routine vocabulary learning.

In order to check this, the teacher conducted a spontaneous survey of 11 students from the class after a year, trying to test the knowledge's portability and sustainability. As a result, 10 out of 11 students mentioned the important ideas of the lesson in such as "standard," "common" and "share" (Table 2). These answers are advanced

in terms of English complexity and conceptual abstractness, and the reason seems to be that the core knowledge acquired a year ago was kept and expressed clearly, using vocabulary and syntax learnt later.

Std B: How about "It tells us *seikakuna* (precise) date"?
Std C: Let's see the handouts.
Std A: Well, can we use the word… "exist"? No, "exact"?
Std B: "Exactly" may be better (referring to a dictionary).
Std A: You don't have to do that. "Exact" is also okay.
Std A: "… Next, the calendar can offer a common time *kankaku* (sense)," I think. How do you say "*kankaku*" in English? "Time feeling"?
Std B: The word "exact" is correct (still referring to the dictionary).
Std A: How about "time feeling"? (Std C: tilting his head)
Std B: "Time feeling" may be related to the clock. The calendar tells us the date.
Std A: Well…, so how about "daily feeling"?

Table 2: Students' answers to the question of why we need a calendar, before, after and a year after the lesson

Std	Before the lesson	After the lesson	One year later
K	(NI)	I think we live everyday, consuning time like oxygen, food, and so on. We had better know how much time we had consuned and how much time is left for us.	I think a calendar enables us to keep connection with others in our daily lives. If it were not for a calendar, we would live independently.
T	A calendar have a function that let my life is going smoothly.	A calendar creates our standard of living. Without being the standard, we can't keep regular hours and feel relieved.	It keeps our standard living.
I	It teach me when the holiday	Calendars are used all over the world. But clocks are not. So, calendars give us the same informations.	(not surveyed)

Teacher learning from designing KCJ classes

Right now, I am in my eighth year of working with the CoREF research unit, and am still engaged in monthly teachers' workshops, material exchange sessions and on-line materials development. As the participants of this research group all have basic knowledge of KCJ, the teachers are equally respected when contributing to materials development. For example, when I reported online that "making worksheets very plain and structured, using a matrix box for example, has been found to be very effective in prompting the students' discussions at the jigsaw stage," other teachers soon afterwards started to use this criterion to review their lesson plans, giving suggestions and making changes. All of this actually happened somewhat at a distance from me, but I know and others kindly acknowledge that my suggestions started to spread. At the same time, I learnt or borrowed from other teachers' practices, adopted them in my own planning, and reported back on whether they worked in my classroom or not. Experienced teachers have a tendency not to acknowledge their *weaknesses,* but in this field of the CoREF teacher network, it is best to try and make errors and to give feedback to each other.

KCJ first challenges teachers and asks why we are here. In order to answer this question, we need to think really hard about why we are here and what exactly we want the students to learn and keep in their mind over the years. The answer seems to lie somewhere near the shore facing the sea of knowledge. Recognizing that we cannot teach unless the students learn is the first step. Then, the students will gradually take a ready step towards the unknown, questioning and finding answers together with their peers.

To me, KCJ is the way to unlock the reservoir of knowledge shared and constructed in class. A few years ago, I answered in an interview that "I do the jigsaw class when I want to learn with students on the same horizon. In that case, I try not only to be the facilitator and 'smoother,' but also to be a trick-maker or a confusion-maker, in order to let them think deeper." However, after attending more workshops and learning together with other teachers, I now think, if the teacher can help, he/she should help in such a way that learning in the classroom becomes more fun and meaningful. The KCJ framework made me think, alter my way of teaching and go beyond the psychological barrier novice or experienced teachers face: "I cannot do this and my students cannot do this."

In the development of learning science, a classroom teacher at elementary and secondary level has three roles. A specimen for a researcher, an on-going researcher, and a monitor to the relation of research and actual teaching experience. This third criteria of monitoring one's own teaching practice and recognizing the value of it in the light of learning science is a gift that this frame work of KCJ classes give.

Networking of networks of the Knowledge Constructive Jigsaw project

Shinya Iikubo and Naoto Hori

This paper reports DBIR strategies that CoREF has taken, especially its networking of small networks of participants. The strategies have mainly two purposes: first, establishing teacher communities of sustained lesson improvement with a focus on design and reflection of lessons within the shared framework of KCJ, and second, supporting the communities by administrative systems which develop in various, sustained forms.

For the first purpose, we have organized CoREF as tiered networks. CoREF leads the pedagogy, and provides frameworks for class practices, assessments, and schemes for running workshops, some as parts of a project activity and some as on-the-job training. The associated boards of education take the lead in concretizing the pedagogy into practice. The organization of CoREF is a hierarchically networked community, within which there are small, overlapping networks of many different types of combinations of teachers, schools, policymakers and researchers. The same teacher can belong to various communities simultaneously according to his or her needs. In other words, we do not recommend a rigid approach such as letting all teachers in one school participate in the project and start all at once, but a more flexible and dynamic approach.

The strategy for implementation is to spread the core pedagogy on how people learn in social contexts and on the learning science basis of collaborative learning practices. All the workshops and joint work between CoREF and its associate members are designed with this strategy, so that the participants can explain the core pedagogy. For example, the first workshop always has teachers directly experience KCJ lessons. These newcomers do not only experience the lesson as students but also reflect upon the improvement of their own answers from pre to post-class, which makes the impossible possible to realize that, even when students are diverse, they surely improve their own understanding. In some workshops, the newcomers exchange experiences of two different types of KCJ lessons to extract "what the KCJ is." The strategy thereafter can be done in diverse ways, such as creation and sharing of practice plans and materials, co-constructions of new lessons, opening their classes to be observed and discussed by newcomers, and developing new assessment methods to better communicate the foundations and outcomes. In expanding these networks, we have come to realize that the needed conceptual change is promoted by providing the newcomers with already established teaching plans, with matching learning materials, so that they can "experience" the differences. To do this, we need lots of good plans, already tested-out in classes, with "practical principled knowledge" conveyed through vivid stories by experienced teachers, which we publish on our website and as a handbook.

For the second purpose, the project has impacted organizations especially through connecting originally divided networks and overlapping networks of differed layers. Our movement had the education boards restructure its teacher support sections as well as the OJT sections, so that those two sections, which have been working independently, work together for better results. In addition, CoREF and an education board of Saitama prefecture conducted personnel exchange which was the first case in Japan: the two persons concerned in Year 2015 are the authors of this paper. After this exchange, the Saitama prefecture and CoREF accelerated overlapping of networks. Figure 1 represents the relations among projects and OJTs. When we started official OJT for initial teachers in Year 2012, we heard that the teachers felt alone inside and outside their schools when implementing KCJ lessons. Thus, we conducted training for supervisors and school leaders so that KCJ could be shared as a common framework to demonstrate and discuss how students learn, regardless of whether they agreed with the framework or not. Accumulation of these projects and OJT during the five years also yielded many experienced teachers who need places and partners to discuss their versions of how people learn. We started the project for nurturing "KCJ and lesson study masters" by collecting applicant teachers from all around Japan up to forty, providing them with more advanced contents of the learning sciences and letting the teachers connect them with KCJ experiences as well as discuss their learning sciences. These teachers are now not only guiding newcomers but also travel all over Japan to conduct KCJ lessons for students in many districts.

Transforming learning at the DBIR level does not mean that a researcher or government committee has the one and only answer to hand down to teachers, but that everyone brings her or his own answer and interacts with one another to construct better solutions, the principle of which should be exactly the same with classroom learning. This is what Miyake wished to realize through her theory of constructive interaction, through the framework of KCJ and many implementation ideas. For teaching learning sciences as learning sciences teach us, we need a concrete form of KCJ. By implementing our initiative around that framework as a shared constraint (this is why we use this word instead of "script"), we find that we can turn the learning sciences into a more real science of practice. That science draws out the children's capacity for yielding new questions, the teachers' capacity for designing new lessons (and even revising the framework and creating their own ones), the administrators' capacity for new systems, and the researchers' capacity for finding new challenges, all of which contribute to building a cultural capacity for innovation based on our potential.

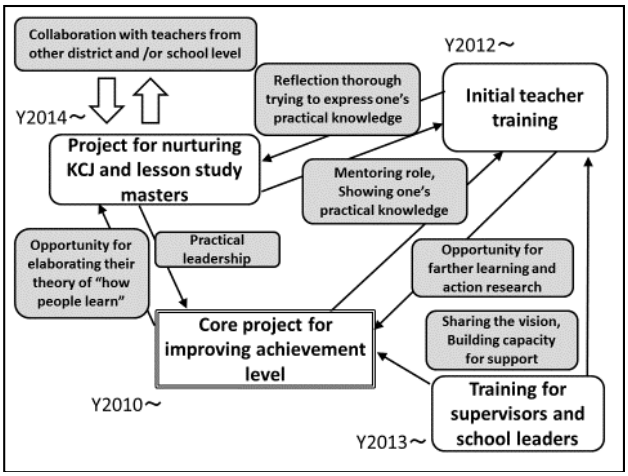

Figure1. Network of projects and OJTs conducted by the education board of Saitama prefecture.

International panel: Partners in Building Cultural Capacity for Innovation

Naomi knew her vision required teams of scholars, practitioners, and policy makers; in that spirit we assemble an international panel of colleagues, some she never met but would be proud to know, who can advance the Building Cultural Capacity for Innovation initiative. Panelists will be representatives from the Americas, Europe, and Asia-Pacific Region. They include directors, deans, and representatives of creative and large scale initiatives to advance education.

In order to lead the discussion, Scardamalia will describe "an international design lab to foster education for innovation." Plans include Knowledge Building innovation networks to connect students, teachers, and administrators; creation of national, linked, hubs of innovation; professional development to reach large numbers of teachers; new technologies and tools to empower teachers and students; data sharing to enable feedback to support ever more advanced accomplishments; resources configured in creative commons with clear research bases; and infrastructure for an initiative international in scope. Overall, the initiative will feature school-university-government partnerships, be research intensive, and span all subject areas taught at all school levels. Partners to the Building Cultural Capacity for Innovation initiative are committed to advancing education in their home nations and through international collaborative arrangements. The final part of the symposium will be devoted to an open discussion between symposium presenters and audience to discuss formal international partnerships needed to share data and to work together.

Naomi's vision for a research based science of practice included designs to share big data not only of achievements but also of learning processes, and to support reflection and action research. Carolyn Rose is the Principle Investigator of a new National Science Foundation award: Big Data Collaborative: From Mining Massive Data Sets to Designing Support for Explanatory Coherence, Consensus, and Action. Carolyn will provide a brief overview of the significant new opportunities for international partners to engage in this research.

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