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Planned educational change in Japan: the case of elementary science instruction[1]

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Available evidence suggests that Japanese elementary science education has shifted, in recent decades, away from lecture-style, rote 'teaching as telling' toward 'teaching for understanding'. How has this change been accomplished? Drawing on our ongoing study of innovations in Japanese elementary science instruction, we describe three features of the Japanese system that may facilitate planned change. First, we describe Japan's broad national goals for elementary education and the alignment of textbooks with these goals. We point out that Japan's national goals focus on the whole child (social, ethical and intellectual development), a breadth which, we speculate, may reduce the kind of pendulum swings between goals of academic and social development that have plagued some other countries' educational policies. In addition, we note that the national goals are abstract and are translated into classroom practice through the collaborative work of teachers. Second, we describe three routes through which the national goals are translated into classroom practice: research lessons, teachers' research groups, and national elementary schools. Finally, we speculate on some elements of the educational context (for example, collaborative habits and norms, beliefs about the pace and nature of change, and the practice of self-critical reflection) that may support planned educational change in Japan.

Introduction

Japanese elementary education has changed dramatically in the decades since World War II. While rote, lecture-style 'teaching as telling' may have been common prior to World War II (Itakura 1978, Kinoshita 1937, Ohashi 1980), recent observers are struck by the emphasis on 'teaching for understanding': on eliciting students' ideas, sparking debate and discussion, and building comprehension through hands-on activies and reflection (Easley and Easley 1983, Hess and Azuma 1991, Lewis 1995, Stevenson and Stigler 1992, Tsuchida and Lewis 1996).[2] How has this change come about?

Our current research investigates how innovations in elementary education, particularly in science, are disseminated in Japan. When we embarked on this research, many colleagues – both Japanese and Western – told us there was nothing *to* be explained. In the words of one colleague: 'Japan has a top-down system, with a national curriculum; they just change the textbooks and tell the teachers to change'. Yet a large body of Western research suggests that teachers cannot be *forced* to change, particularly if the change in question – like the change from 'teaching as telling' to 'teaching for understanding' – asks teachers to think in fundamentally new ways about what learning is and how it occurs (Fullan and Stiegelbauer 1991, Gardner 1995, Heaton and Lampert 1993).

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For several decades, Japan's Ministry of Education, Science and Culture[3] has promoted goals of student autonomy (*shutaisei*), student initiative (*jihatsusei*), active desire to learn (*mizukara manabu iyoku*), and problem-solving capacity (*mondai kaiketsu ryoku*) for elementary students; these terms continue to be prominent in recent national guidelines (Monbushou 1952, 1960, 1989a, b, 1993). For example, the 1960 national elementary science guidelines advocate that: 'It is desirable to guide children in ways that build an active, independent (*jishuteki*) attitude toward learning . . . and important to be careful that we don't suppress children's own initiative and discoveries' (Monbushou 1960: 193–96). The 1989 Course of Study continues the theme: 'In teaching all subjects, along with emphasizing experiential activities, we need to use approaches that nurture children's interest and engagement and that foster active, independent (*jishuteki*) learning'.

Cross-national comparisons suggest that Japanese elementary educators do indeed try to implement goals of student autonomy and initiative, measured by indices such as student involvement in debate and discussion, opportunities for student thinking, and hands-on experimentation (Keeves 1992, Stevenson and Stigler 1992, Stigler *et al.* 1996, Tsuchida 1993).[4] The focus in Japanese elementary schools on eliciting students' ideas, stimulating discussion and debate among children, and promoting students' active reflection is even more strongly noted in ethnographic and observational studies of Japanese classrooms (Easley and Easley 1983, Lewis 1995, Tsuchida and Lewis 1996). These studies strongly counter the image of rote, authority-based learning conveyed by many popular press accounts of Japanese elementary education, and hence come as a surprise to many Westerners.

When asked to compare his own science education as an elementary student with current practice, an assistant principal and 25-year veteran of Japanese elementary teaching told us:

> The changes that have occurred since I was a child are changes in the whole elementary education system, not just in science: increasing students' autonomy, emphasizing 'learning how to learn,' taking initiative to learn rather than just memorizing what one is told. These are the changes that have shaped not just science but other subjects as well in the 25 years that I've been teaching.

The kind of education the Ministry of Education advocates – emphasis on problem-solving capacity, student initiative, active engagement in learning, etc. – overlaps substantially with the reforms that many US educators have pursued over the past decade under labels such as 'constructivist teaching', 'student-centered instruction', and the shift from 'teaching as telling' to 'teaching for understanding' (Cohen *et al.* 1993). These reforms have been elusive in US classrooms, many commentators suggest, because they require teachers to change very basic assumptions about how children learn, and to master techniques that will support student discussion and reflection (Cohen and Ball 1990, Darling-Hammond 1990, Elmore *et al.* 1996). Important features of student-centred instruction (such as peer discussion) are often lost when the approach is 'domesticated' to fit US practitioners' beliefs about instruction (Olson 1981). Even in a relatively centralized educational system like Japan's, where textbooks and policy can be mobilized in support of new goals, the burden on teachers – to understand the new vision of learning, and implement new features such as peer discussion – is likely to be great.

How, then, has Japanese elementary education managed to change? Based on about 60 interviews and observations at about 25 Japanese elementary schools over the period 1989–96, we describe the effort to bring two science education innovations into practice during that period.[5] The first is the 'new concept of academic ability'

(*atarashii gakuryokukan*) introduced in the 1989 tentative revision of Japan's *Course of Study for Elementary Schools*. This new concept of academic ability emphasized

> an attitude of approaching objects actively, with interest and concern; the ability to synthesize diverse information in different situations, and to think, judge, and act flexibly; and the ability to express oneself abundantly and concretely, and to persuade others. (Monbushou 1993: 1)

The Ministry emphasized that the new academic abilities required a new role for teachers, who must 'discover and affirm the strengths of each individual child' and allow children to 'exercise power themselves and achieve their own desires'.

Along with its emphasis on 'a new concept of academic ability', the 1989 revision of the *Course of Study* installed a new subject, Daily Life Studies (*Seikatsuka*), at grades one and two, eliminating science and social studies from those grade levels. Daily Life Studies was to embody the new concept of academic ability, by emphasizing student initiative, individuality, and active problem-solving. Significantly, this change represented the first abolition of a curricular area in the 40-year history of the *Course of Study for Elementary Schools*.

How, then, did Daily Life Studies and the 'new concept of academic ability' move from policy into practice (or fail to do so)? From these examples, what we can learn about how educational change is implemented in Japan? This preliminary account will focus on three issues: Japan's system of national educational goals and aligned textbooks; structures through which Japanese teachers translate policy into practice; and the context for educational innovation in Japan.

Broad national goals and aligned textbooks

Although commentators frequently speak of Japan's 'national curriculum', this is actually somewhat of a misnomer. What exists is a fairly general set of goals for elementary education and a textbook approval system aligned with the goals. We describe these two elements briefly.

Japan's national Course of Study

Japan's national goals for elementary education are contained in the *Course of Study for Elementary Schools* (*Shougakkou Gakushuu Shidou Youryou*), a remarkably frugal document that is revised approximately once every ten years.[6] The most recent revision, which was published in 1989 to take effect in 1992, spans just 122 pages of a half letter-size booklet. It covers nine subjects (language arts, mathematics, science, social studies, daily life, music, arts and crafts, home economics, and physical education) and two non-subject areas (moral education and special activities).

The *Course of Study* focuses on the whole child (social, intellectual, physical, ethical, aesthetic, and emotional; Lewis 1995). It lays out abstract, general goals, not specific outcomes. For example, the overall goal for elementary science is:

> Through familiarizing oneself with nature and conducting observations and experiments, to nurture hearts that love nature, the ability to solve problems, and the acquisition of scientific ways of thinking and perspectives on natural objects and phenomena. (Monbushou 1989b: 58)[7]

Under this overall goal for science, the *Course of Study* specifies goals for each grade level in each of the areas of elementary science (biology, physical science, and earth

and planetary science). Once again, these goals are broad and somewhat abstract. For example, the third grade objective for biology is:

> Through investigating and comparing the structures of plants, animals, and human beings in children's immediate surroundings, and through active involvement in pursuing problems of interest and concern, to nurture in children a loving attitude toward living things, and to help children acquire ways of thinking and perspectives on the structure and growth patterns of living things. (Monbushou 1989b: 58)

Under this objective, the content is further specified in three items, one each related to plants, insects, and humans. For example, the item on plants specifies:

> (1) To allow [students] to investigate the process of growth and body/plant structure by letting [them] take care of or look for familiar vegetation. (a) [To learn] that plants have a consistent sequence in their growth and that some plants can grow from roots or stems as well as seeds, and (b) [To learn] that the body of plants consists of roots, stems, and leaves and that each part has unique characteristics. (Monbushou 1989b: 58)

An additional volume for each subject area (the *Shougakkou Shidousho*, or *Elementary School Teaching Guideline*) provides further guidance about the content to be taught at each grade level; like the *Course of Study* itself, however, these volumes are small and thin, and do not specify the particular teaching materials to be used. The volume for elementary science, for example, covers 116 half letter-size pages, and further elaborates the content of third grade plant biology only as follows:

> As they handle plants and animals in their immediate surroundings and observe human life, the objective [of science] is to [help students] acquire ways of thinking and perspectives on the structure and growth patterns of living things; to promote the ability to pursue problems of interest and concern; and to nurture in children a loving attitude toward living things. For example, to help [students] grasp the body structure of living things and the growth patterns by allowing [them] to investigate the sequence of plant growth and the characteristics of roots, stems, and leaves; to examine differences in food and characteristics of body structure of insects by looking for or taking care of plants and insects in immediate surroundings. (Monbushou 1989a: 16–17)

Despite guidelines so general, the little available evidence suggests that Japanese instruction is generally uniform and of relatively high quality at elementary schools in diverse parts of Japan (Keeves 1992, Stevenson and Stigler 1992, Tsuchida 1993). Why?

Textbooks

Textbooks are, of course, one important route by which national policy reaches the classroom. To be approved for use, textbooks must cover the content laid out in the *Course of Study* and *Guidelines*. As one teacher at a national elementary school remarked:

> Teachers rarely refer to the *Course of Study* when planning lessons. We might return to it at a time when we're planning a research lesson, but not routinely. The textbook is what's used routinely at most schools. The textbook incorporates the *Course of Study*, so if you use the textbook, you're OK.

Since the intent of the new Daily Life Studies subject was to increase children's initiative as learners, and decrease their reliance on teacher-defined questions and activities, initially textbooks were not created. Like moral education (which has no textbook), Daily Life Studies was regarded as a subject that would incorporate many different daily activities or occurrences at a particular school. But as the piloting progressed, teachers strongly voiced their need for textbooks, and in response, the Ministry advocated the development of textbooks. One Ministry of Education

official involved in establishing Daily Life Studies and writing its national guidelines told us:

> I think textbooks were considered to be necessary to help teachers learn what this subject was all about . . . I think the textbooks play a significant role [in dissemination]. Japanese education is called 'textbook-driven education', because it has valued textbooks very highly since the Meiji Era [i.e. since 1868]. Thus, there is a common conception or image among people that a subject isn't really an important subject unless it has a textbook. In principle, I don't think Daily Life Studies needs a textbook. However, if it didn't have any textbooks, teachers might think Daily Life Studies was not important . . . On the other hand, some people make the criticism that teachers don't do anything beyond what's written in the textbooks – that the textbooks limit teachers' creativity. I think there is some truth to that.

Nevertheless, most of the Daily Life Studies textbooks have little written text. They feature pictures of local festivals, businesses, and animal and plant life that are intended to be the focus of the new subject.

For elementary science, six approved textbook series compete for adoption by local school districts. All six cover the same basic content; differences are minor. For example, one textbook's experiment uses a voltage meter whereas another uses car speed when students examine the power of light on a solar battery. Because textbooks translate the national *Course of Study* into classroom lessons, teachers who follow the textbook know they are covering the national requirements. Yet, like the *Course of Study*, textbooks are sparse. For example, looking at two of the approved textbook series, we find that the entire fourth grade electricity unit, which normally takes ten class periods, covers just 12 to 13 pages of a half-letter size textbook, with most of the textbook space devoted to colourful illustrations of students conducting experiments with conventional and solar batteries. The small amount of student text emphasizes questions ('For a solar battery, does the current's strength change depending on the light?') and 'Let's do' statements ('Let's block the light to the solar battery'). It's not surprising, then, that Japanese teachers often talk about textbooks more as a base or starting point for instruction than as a full blueprint for instruction. When we asked whether Japanese textbooks would allow American teachers to replicate Japanese science education, one teacher in a Japanese national elementary school answered:

> The textbook provides the bare minimum of information. You need to expand it. The textbook alone wouldn't be enough to do lessons in America; you'd need the teacher's manual too. But I guess that if you took the teacher's manual and textbook to America, it would enable American teachers to do [the Japanese] lessons, in the same sense that the McDonald's manual ensures that when you go into a McDonalds anywhere in Japan, they give you the same meal, they talk to you using the same words. It would get everyone to a certain level. You wouldn't have big failures. But to get to the next level, you need to move beyond the textbook and manual.

In addition to laying out the minimum information that students must master, we suspect that Japanese textbooks link policy and practice in two additional ways. First, our limited interviews to date suggest that Japanese elementary teachers may heavily influence textbooks. Teams of classroom teachers serve as advisors to particular textbook companies, often working together for years or decades to hone the textbook's examples and experiments, suggest revisions, and add 'hints' to the teachers' manual based on their own classroom experiences. They decide collaboratively what the implications are, for textbooks, of abstract Ministry guidelines such as student 'autonomy' and 'initiative'. Textbook companies actively recruit as advisors promising young elementary teachers who participate in research circles and public lessons (see below); these relationships often last a lifetime. At the end of an interview with a group of teacher–advisors to a textbook company, we complimented them on their

energetic discussion of the Ministry's vague goal of creating children who have 'the strength to live'. One teacher gravely replied: 'We have to discuss this goal energetically, and draw out its implications for science. The science knowledge of Japan's next generation depends on the decisions made in this room'. We uncovered no studies on the role of teachers in textbook creation in Japan, but our impression is of substantial, long-term involvement by skilled practitioners, often in collaborative groups (rather than as sole authors). Quite possibly, Japan's science textbooks reflect the consensus of some of the country's most skilled practitioners about what constitutes the best teaching of the nationally required content; more research is needed regarding this possibility.

A second interesting issue is that textbooks may act to *limit* the content Japanese teachers feel they must cover. US science textbooks cover many more topics than the international average, and many more than teachers can be expected to cover in any reasonable depth (Schmidt *et al.* 1997). In contrast, Japanese science textbooks cover a relatively small number of topics; textbooks must fit within a very modest page limit (slightly over 100 half letter-size pages). Further pressure to limit content comes from the textbook approval process; the textbook publishers' trade newsletter lists many examples of textbooks disapproved because they were judged to provide content *in excess* of that required by the *Course of Study*. For example, a publisher was asked to revise textbooks so that electricity experiments used only two batteries (not three). (Textbook examiners were reportedly afraid that inclusion of three batteries would give junior high schools the green light to devise difficult entrance exam problems involving three batteries.) Similarly, a publisher was asked to drop the label 'cow dung' from an elementary textbook illustration showing a grass-eating cow in the sunshine, in order to discourage any impression that elementary school students should master the whole photosynthesis cycle. These examples are interesting because talk about standards, textbooks, and curriculum in the US generally addresses the question of *ensuring* coverage, rather than *limiting* coverage.

In summary, Japan has a national *Course of Study* and textbooks aligned with it. The *Course of Study* focuses on the whole child, and is remarkably abstract; while these qualities initially surprised us, we speculate below that they may be important in giving classroom teachers the room to 'reinvent' policy in the classroom, and in providing a broad framework that limits pendulum swings between social and academic development or between competing visions of academic learning.

Means for teachers to translate policy into practice

When asked how the 'new concept of academic ability' and the new Daily Life Studies subject area have made their way from policy to practice, teachers and principals have repeatedly described three routes: national schools; research groups; and research lessons. We discuss each of these briefly.

National schools

Since Japan's first national elementary school was established more than 120 years ago, national elementary schools have been leaders in teacher-initiated research on curriculum and instruction (Kurasawa 1963). More than ten years before Daily Life Studies

and the 'new concept of academic abilities' became official policy, teachers in national elementary schools worked to formulate these ideas and try them out in the classroom. As one national school teacher said of the periodic revisions in the *Course of Study*: 'When a revision occurs, we're already thinking about the next revision that will be made ten years down the road; our job is to create the next set of changes'.

Most of Japan's 73 national elementary schools are affiliated with national universities, and some train student teachers. Each prefecture has at least one national elementary school, and teachers at these schools serve as conduits between policy and practice in many ways: by regularly conducting 'research lessons' (see below) that are open to teachers from other schools; by serving as observers and discussants at research lessons in ordinary elementary schools; by publishing teacher-oriented books and journals that include lesson plans, records of their own classroom experiences (*taiken kiroku*) and reactions to the new policies; and by hosting teachers-on-fellowship who study in the national schools for periods ranging from several weeks to a year. National elementary schools differ in how they select the student body (typically by some combination of lottery and examination) and faculty tenure (some have permanent faculties, while others hire teachers for a four- to six-year period who then return to local elementary schools). Common to all national elementary schools is that they attract faculty who are leaders in the improvement of instruction and curriculum. As one national school teacher commented: 'When I taught in a regular elementary school, we teachers talked a lot about how to teach the science curriculum; here, we talk a lot about what Japan's science curriculum should be'.

Teachers' research groups

A second route between policy and practice is teachers' research groups. Both grassroots, teacher-initiated study circles and publicly supported study groups dot Japan's educational landscape. We could locate no published estimates of their membership, but interviewees estimated that between 10 and 50% of elementary teachers belong to teachers' research groups. 'Research' in this context means classroom-based efforts to improve instructional approaches, usually by studying and discussing a large idea – such as 'problem-solving capacity' or 'desire to learn' – with fellow group members, attempting to reshape classroom instruction in keeping with this idea, and sharing the resulting practices with colleagues (by visiting each other's classrooms, videotapes or reports). Although such research often involves careful study of one's own classroom (by analysing teacher and student talk, measuring the extent of student participation, analysing student work, etc.), it almost never involves a comparison group, random assignment, controlled conditions, or other hallmarks of experimental research.

The teacher research groups vary greatly: some meet weekly whereas others meet just a few times a year; some are sponsored by the local Board of Education, take place on paid time, and focus on officially sanctioned content; others are initiated by teachers and pursue content outside of or even opposed to the current *Course of Study* (for example, there are teachers' study circles devoted to whole language instruction, human rights, and the study of pollution). Teachers we have interviewed to date say that they receive no special pay or academic credit for participation in research groups, but they note that an active research career is important for teachers

who wish to become principals later in their careers. Some research groups confine their attention to a particular discipline (e.g. science, social studies, physical education) while others pursue topics or philosophical issues that cut across disciplinary boundaries.

In the research group meetings we have attended, discussions have embraced both 'big' issues of theory and fine points of classroom technique, a breadth well-captured in the name of one well-known teachers' research group, The Polar Method Group. This odd name likens teaching to polar exploration, in that it requires extraordinary advance planning, training and knowledge, but – because it is inherently unpredictable – ultimately relies on good judgement in the moment, not on fixed scripts.

Elementary teacher Yoshio Tamura reflects on his 15 years of membership in a science teaching research group:

> [Before I joined the teachers' research group], I had always seen education as teachers giving knowledge to children, as a top-down process. Through my work with the elementary science research group, I came to see education not as giving knowledge to children but as giving them opportunities to build their own knowledge. Initially, that was not what I believed. Even when I saw it in practice, I couldn't believe in it at first. When I first saw lessons in which children were building their own knowledge, I thought 'Is this kind of instruction really OK? It takes so much time.' But then I began to realize that if children don't experience something, they don't understand it. They can memorize it but when the time comes to use it, they can't.

In his tenth year as a teacher, when colleagues from across the city gathered for a research conference for tenth-year teachers, Mr Tamura suddenly realized how much his seven years of participation in the science teaching research group had improved his teaching, even compared to colleagues who had majored in science:

> I was really surprised that an old college classmate of mine, who happened to be a science major in college, did a demonstration lesson which he began by saying 'Let's open our textbooks to page so and so'. Many of us were very surprised by that, and criticized it heavily. It's the kind of lesson you'd really laugh at if you saw it now. And he was someone who had been teaching for ten years. At that moment I realized that it's not a matter of what you specialize in in college, but of how much you study and work to improve your teaching after becoming a teacher. The knowledge you gain by majoring in something is important, but more important is what kind of studying you do after you become a teacher. At the same conference, a representative of my research group did a demonstration lesson, and many other members of my research group presented reports of lessons – usually lessons we worked on in groups and then one person presented the report. Our report had to do with children's understanding (*ninshiki*) of various concepts, so it was the sort of thing that a teacher who just taught from the textbook would never think about. Our work was a shock to those teachers, the same shock for them that I received when I first came to the science research group as someone who thought that just following the textbook was fine. I think they'd never thought about things like how the children were understanding concepts.

Research lessons

Mr. Tamura's work with colleagues to develop and present lessons introduces a ubiquitous feature of Japanese elementary education: research lessons (*kenkyuu jugyou*). As it does for teacher research groups, 'research' in this context means teacher-initiated, practice-based inquiry. Japanese research lessons come in many styles and sizes. What is common to all research lessons, however, is that they are unrehearsed – although well-prepared – lessons with real classroom students. Commonly, the research lessons are designed to show how an abstract goal – such as building children's 'desire to learn' or 'initiative' – can be fostered in the classroom, or to demonstrate innovations in curriculum materials (for example, using swing sets to study pendulums). Although a research lesson is ultimately taught by one teacher – with

many colleagues crowded into the sides of the classroom to observe and record – it is often planned and tested by a group of teachers working collaboratively for many months.

Research lessons take several distinct forms. Like the research lessons in which Mr Tamura 'first saw children building their own knowledge', research lessons often occur as part of teachers' activity in professional groups outside of school. Often, members of a research circle decide on a theme they want to pursue (for example, promoting students' 'empathy' or 'self-initiated learning'), discuss and critique each other's plans for incorporating this goal in classroom practice, and then observe each other's lessons. The conference of tenth-year teachers, where Mr. Tamura was shocked to see a teacher begin his lesson by saying 'open your textbook to page . . .' is also an example of a research lesson sponsored by a professional group – in this case, a mandatory program for tenth-year teachers from all of the city's schools. When we attended the annual conference of Japan's Elementary Science Education Association, we were surprised to find that about two-thirds of the conference time was devoted to research lessons. Teachers fanned out to local elementary schools, to observe and discuss dozens of research lessons that went on simultaneously over the entire schoolday.

A second form of research lessons is public lessons (*koukai jugyou*). When elementary schools obtain public research funds – for example, to shape the new Daily Life Studies curriculum – they typically culminate their work by presenting research lessons that are open to teachers from other schools. Several times a year, national elementary schools open themselves up for public research lessons; these public lessons are conducted throughout the school, for one or more days, sometimes attracting upwards of 3000 teachers a day. Teachers from ordinary local elementary schools across Japan, as well as researchers and policy-makers, attend these national school research lessons in order to 'see where Japanese education is going', 'find out what's new', and to see in action new emphases and approaches.

Public research lessons in Daily Life Studies, over the period of our research, have been very heavily attended, because they provide an opportunity to see in action a new subject area that teachers themselves did not experience as children. When asked how he had built the new Daily Life Studies curriculum at his school, an assistant principal at a public elementary school outside Tokyo said:

> The way to improve Daily Life Studies is to see many good actual examples. We can do that by going to lots of schools that are doing presentations and research lessons on Daily Life Studies. Many people from this school have gone. Each school has its own way of approaching the new subject. Some are appropriate for your school, some aren't. What works elsewhere might not work at your school because the children are different. So you need to see lots of examples.

The third, and perhaps most basic, form of research lesson is the 'in-school research lesson' (*kounai kenkyuu jugyou*). In-school research lessons are a regular, ubiquitous feature of life at elementary schools throughout Japan, occurring as frequently as several times a month, or as infrequently as several times a year. These research lessons are open to the school's staff; sometimes, one or more outsiders are also invited.

An in-school research lesson at Mitsuno School illustrates how research lessons can link science education policy to practice. Mitsuno School is a local public elementary school in Tokyo; in-school research lessons are conducted six times a year. Responsibility for the research lessons rotates through all 25 teachers in the school, who work collaboratively in three groups (primary grades, middle grades, and upper grades) to plan and conduct the lessons. 'To promote students' problem-

solving skills' is the theme chosen by the faculty to guide this year's research lessons – a theme that may be extended for several years, depending on the faculty's assessment of their own progress. We observed a fourth-grade research lesson on solar energy, a topic newly added to the study of electricity in the most recent revision of the *Course of Study*. During this lesson, the principal, vice-principal, all members of the teaching staff, and an outside advisor observed the lesson from the back and sides of the classroom. Several teachers with clipboards recorded all speech between teacher and students. Another teacher videotaped the entire lesson. The remaining teachers wrote comments on sheets of self-adhesive labels, which they later organized by theme and copied for all participants.

The teacher, Mr Hori, began the lesson by reminding the students of a problem they had encountered in the previous lesson: how to increase the power of solar cells so that their solar-powered toy cars would run faster. Students spent the lesson conducting experiments designed to increase the solar cell power and then shared their findings with the class. At the end of the lesson Mr Hori summarized the students' findings in a single sentence, which he wrote on the board. After a short break, the faculty assembled to discuss the lesson. A representative of the middle-grade teachers explained which of the school's goals they had chosen to emphasize in their research, and why. Mr Hori presented his reflections on the lesson, commenting that he was pleased with the enthusiastic involvement of his students, and confessing a difficult decision he faced: when students spontaneously conducted extra experiments, he realized that he might not have enough time to summarize the lesson well, but decided to go ahead and conclude the lesson as he had planned.

Next, the floor was opened to discussion. Several teachers remarked on the uncontrolled experiments done by many students, and wondered out loud whether it would have been better for Mr Hori to ask students to control variables in their experiments. In contrast, other teachers praised the fact that the experiments came directly from the children's thinking; they pointed out that today's lesson sensitized students to several variables (distance, brightness, angle, etc.) likely to affect solar cells, and that this experience might provoke students to think about controlling variables in subsequent experiments with the cells.

Both upper-grade and lower-grade teachers suggested that Mr Hori should have used students' words, rather than his own words, in the lesson summary. 'I felt sorry for the students when the teacher concluded the lesson with his own summary statement', said one teacher. Mr Hori 'forcibly' pushed students' results into his own summarizing statements, commented another. Yet other teachers disagreed:

> I don't agree with several teachers who think that students' ideas were somehow stifled by the teacher's summary. As someone who doesn't know much about electricity, I found the teacher's summary helpful. Students who, like me, have limited knowledge about solar cells may have found the teacher's statement helpful, after hearing such a wide variety of opinions.

Teachers also talked about the purpose of studying solar cells. One teacher asks:

> I haven't taught fourth graders for a while, so I have no idea how and why solar cells became a new curriculum material. I'm only guessing that including solar cells reflects adults' hope that children will become the next generation of scientists who will become interested in solar energy and thereby help Japan. Science education specialists might be concerned about children using the proper vocabulary or setting up certain experimental conditions, but if the goal of including solar cells in the curriculum is to get children interested in the fact that electric current can be changed by light, then Mr Hori's lesson fulfilled that. So I'd really like to know the reason why solar cells were included as a new curriculum material for fourth graders.

In addition to the discussions of curriculum and debates about Mr Hori's teaching strategies, teachers offered many positive comments on the lesson. They noted children's evident skill in working together and their enjoyment of experiments they themselves designed; Mr Hori's warm relationship with the students, despite having come to the school just two months earlier; and his clear and lively style of communication.

Comments from an invited outside advisor concluded the meeting. The advisor, Mr Morinaka, was a principal in a nearby school who had served on a Ministry of Education science curriculum committee. He expanded on one of the goals emphasized in the research lesson – 'Not to teach children but to assist children in acquiring learning' – as follows:

> Children ought to develop questions through their own hands-on activity, rather than conduct experiments simply because a teacher directed them to by asking a question like 'What would happen if you connect batteries in series or in parallel?' I found it impressive that Mr Hori allowed children to share their ideas freely in today's lesson. But in many research lessons, teachers do not take the next step and anticipate what will happen if children conduct the experiments of their choice, nor do they help children move up to the next level of thinking. Children must engage in activities with a prospect (*mitooshi*) in mind. Without a prospect in mind, children's observations and experiments will be in vain.

Research lessons as a bridge between policy and practice

In what ways might research lessons like that at Mitsuno School serve as a bridge between policy and practice? Perhaps the most obvious way is that they give teachers a chance to discuss new curricular content, such as solar cells. The research lesson provided an opportunity for teachers at Mitsuno School to discuss the purpose of adding solar energy to the curriculum and to deepen their own content knowledge about solar energy. One teacher asked:

> I want to know whether the three conditions the children described – 'to put the battery closer to the light source', 'to make the light stronger', and 'to gather the light' – would all be considered the same thing by scientists. They don't seem the same to me. But I want to ask the teachers who know science whether scientists would regard them as the same thing.

In addition to exploring a new content area (solar energy), the research lesson explored new approaches to learning advocated in national guidelines. The faculty's choice of problem-solving as the theme for their schoolwide improvement effort was not just happenstance. Problem-solving had been prominently featured in the Ministry's descriptions of the 'new learning abilities', and teachers in many parts of Japan were actively debating just what problem-solving was and how it could be fostered. Although the Ministry had described students' problem-solving abilities as a critical goal of 'present and future science education' (Monbushou 1993: 3), its development was described only in the most general terms: for example, as a product of 'a sense of self', 'initiative', 'independent thinking and judgment' and 'expressiveness'. Although Mitsuno School's teaching staff didn't specifically refer to any Ministry documents or guidelines, their school improvement theme ('to use teaching approaches to promote students' problem-solving abilities') could be seen as an attempt to define, for the real world of classroom life, ideas central to the national guidelines. One teacher told us:

> The research lesson system is valued very highly by Japanese teachers. You find it even in very isolated mountain schools, where there are fewer than 20 students. You won't find a school without research lessons. That's

one reason why the education throughout Japan is fairly standard, whether you're talking about Tokyo schools or the remotest mountain school.

As many students of school change have noted, before teachers can successfully implement a new curriculum or approach to learning, they need to figure out what it means, see it as important, and figure out how it can be done in their own setting (Cohen and Ball 1990, Darling-Hammond 1990, Fullan and Stiegelbauer 1991). Although this is likely to be a messy and time-consuming process, deep, long-lasting implementation is unlikely to occur without such an opportunity to 'reinvent' policy in the classroom. Research lessons can be seen as one arena for reinventing policy: for exploring its big ideas and the concrete techniques that bring it to life in the classroom. For example, several attendees commented that Mr Hori's design of the lesson so that students wanted to see their cars run faster was preferably to a lesson in which students performed an experiment simply because it was suggested by the teacher; they linked this to the goal of increasing students' motivation to learn.

Research lessons are not simply individual professional development; they are guided by a school's ongoing focus of study or improvement, for example: 'autonomous learners', 'children who discover problems and try to solve them with their own strength', or 'school-wide activities to foster students' empathy (*omoiyari*)'. Although some schools change their improvement focus after just a year or two, it is not unusual for a school to maintain the same focus for four to six years. For example, one national elementary school that has focused for the last six years on 'fostering students' individuality', has changed its sub-theme only slightly each year, to explore how different materials, approaches, and subject areas relate to their efforts to foster individuality. Schools' themes for study and improvement often relate to recent or anticipated changes in the *Course of Study*, and to debates being waged at the national level. Yet teachers see these themes as coming from their school itself. In a local public elementary school where goals are based on discussions and questionnaires that solicit opinions of teachers, parents and students, the assistant principal told us: 'These are our school goals. They don't come from the outside. They're ours. Our school goals stay the same, with perhaps minor modifications, for many years'. Like national goals, school goals are broad, and typically encompass social as well as academic development.

The personnel who attend research lessons provide another bridge between policy and practice. It's not unusual for well-known classroom teachers, administrators and researchers to visit dozens of elementary schools each year, in order to serve as commentators on in-school research lessons. Often these commentators are the pioneers of a new subject area or approach – the teachers and researchers who first conceived of the need to focus on 'individuality', or 'initiative' or to include solar energy in the curriculum. And so the research lessons may serve as a kind of nationwide formative research, in which thinkers at the centre of a reform get the chance to see how it is being interpreted by teachers, implemented in classrooms, and received by students. At the same time that Mr Morinaka shared information on why solar cells had been added to the curriculum, he no doubt gathered information on how the new subject matter was being understood by teachers, on their level of comfort with the new materials, and on students' reactions – essential information for evaluating and improving policy.

Finally, a striking feature of the research lessons is the fact that teachers with different views of learning exchange ideas about a shared, concrete lesson. Differing views of education regularly bump up against each other in the discussions following

research lessons, resulting in lively debates, such as whether Mr Hori was right to summarize the lesson in his own words – or whether he robbed the students of the opportunity to make sense of the lesson. The following exchange occurred in the discussion following a research lesson at a national elementary school:

> *Host Teacher*: We have the feeling that recently in science education the process has been over-emphasized, and the results and conclusions under-emphasized. We feel that the conclusions – what you might want to call children's knowledge – have been under-emphasized of late. Why is a lesson OK simply because children are active?
> *Visiting Teacher*: If children are making connections with daily life, then that's science. [Reads a quote to that effect from the science *Guidelines*.]
> *Host Teacher*: Not just any kind of experience qualifies as science. If children leave here thinking that weight makes a difference in pendulum swing, then there's something wrong with the scientific process that's going on here.
> *Visiting Teacher*: Do you call it scientific reasoning if they get the right answer, but not if they don't? When does it suddenly become unscientific thinking?
> *Host Teacher*: I can't believe that the path could be scientific and the conclusion not be.
> *Visiting Teacher*: But students' observational ability may be insufficient [to draw the right conclusion]. What's wrong with just *telling* children about measurement error? They'll understand it.

The viewpoints that bump up against each other include not just differing views of learning, but of the broader goals of human development that are strongly emphasized by Japan's *Course of Study*. One teacher recalled how, early in her career, she burst into tears after seeing a wonderful research lesson by her fellow first-grade teacher:

> I felt so sorry for my own students. I thought their lives would have been so much better if they'd been in the other teacher's class. You realize you have had a big impact on your students. You see how authoritarian teachers have very quiet classes. Teachers who value students' ideas have very active classes. You see how teachers are creating a class, not just learning a lesson. The teacher's way of speaking and the teacher's way of getting angry are all passed on to the students.

Through the shared concrete research lessons, teachers define collectively not just what innovations mean, but how education's many goals (for children's social, ethical, and intellectual development, for content knowledge and thinking process) will be balanced. As the national school teacher asked, is active learning good just because it's active? Research lessons ensure that teachers with differing beliefs will continue to see and give feedback on one another's practice – rather than talking only with like-minded colleagues. We suspect that such shared discussion of real classroom lessons helps teachers keep in mind education's many goals, recognize the benefits of approaches different from their own, and avoid extreme pendulum swings as innovations are put into practice.

The context of planned educational change in Japan

So far we have briefly described the *Course of Study*, the textbook approval system, and three routes linking policy and practice: national schools, research groups, and reseach lessons. But we have not explored the beliefs and practices that support these structures (see McLaughlin and Talbert 1990, and Little and McLaughlin 1993 regarding the importance of this issue). Based on our evidence to date, we note four constellations of beliefs and practices that may provide essential support for the shift in science education: beliefs and practices related to the pace and nature of educational change; collaboration and 'borrowing' among teachers; self-critical reflection; and the responsiveness of national policy to teachers' concerns.

1. The pace and nature of change

The long time frame allowed for the shift to Daily Life Studies is noteworthy. Although the guidelines for the new subject were published in 1989, Daily Life Studies was not required until 1992. From 1988 through 1995, four successive waves of schools (usually including at least one school per prefecture) participated in the development and demonstration of the new subject area, giving teachers time to attend research lessons at the schools involved in the trial phases, and to experiment in their own schools. And the roots of the change stretch much further back into the past. One national official told us:

> Daily Life Studies became a subject in 1989. But long before that, maybe from the 1970s, many opinions were voiced in favor of a subject area like Daily Life Studies. First and second graders have a hard time sitting still. So if you ask them to write something in their notebooks and memorize it, they aren't thrilled. Taking these young students into consideration, since the 1970s people had the thought that it would be better to create a subject that values learning through direct experience with one's body. In order to create such a subject area, abolishing social studies and science for the lower grades was considered. However, many strong objections were expressed. Only in 1989, after about 20 years of debate and discussion, was Daily Life Studies established.

The 1989 *Guidelines for Daily Life Studies* also confirm that 'it took about 20 years of consideration until the new subject area, Daily Life Studies, was established' (Monbushou 1989b: 1). Teachers had a lengthy period to experiment with new approaches and ideas. As noted above, the guidelines for Daily Life Studies and the 'new academic abilities' were published and disseminated three years before they actually went into effect, and these guidelines were the product of years (perhaps even decades) of experimentation and discussion. The long-term perspective on change was underlined by a national educational bureaucrat, who told us:

> We change the *Course of Study* about every ten years. But the truth is that ten years is too short a time to change classroom education. If we greatly changed the *Course of Study* every ten years, teachers would be turning their heads this way and that so often that their necks would break. So we make major changes in the *Course of Study* only every twenty years or so, and in between it's just fine tuning.

The multiple, frequently changing demands on American teachers have been cited as enemies of the time and sustained focus needed for school change (Elmore 1996, Fullan 1996). The Japanese system may emphasize slow change and expect policy to be reinvented in the classroom, creating a much more supportive context for change.

2. Collaboration and 'borrowing'

Collaboration tends to be well-established in Japanese schools (Lewis 1995, Rohlen 1983). For example, the entire faculty generally meets together briefly each day. They jointly plan and carry out a host of schoolwide activities, such as sports days, school festivals, and school trips. They formulate schoolwide goals (such as 'problem-solving' or 'warmheartedness'), relate all schoolwide activities to these goals, and regularly reflect together on their progress toward the goals. Grade-level teachers plan out the year's lessons together, discuss their specific plans for upcoming lessons, and exchange information on how lessons went in each classroom. Research lessons are thus an extension of widespread collaborative practices already in place. Research lessons can link individual teachers to school goals and school goals to national policy because of the collaborative goal-setting that is in place.

Shared subject matter may provide another important support for collaboration. Given the fact of national curriculum guidelines, teachers are likely to invest energy in developing original approaches to the required subject matter, rather than in developing wholly original lessons. We were struck by the power of a shared curriculum during a discussion following a research lesson (a third-grade lesson on magnets) at a national school in Tokyo. One visiting teacher mentioned that her students overgeneralized from the study of electricity to magnetism, concluding that objects must be in contact for magnetic force to flow. This comment provoked a lively exchange among the 20 or so teachers from various elementary schools attending the lesson, many of whom had encountered the same problem and offered advice on dealing with it: to teach magnetism before electricity, to add an experiment that explicitly compared contact and no-contact conditions for magnets, etc. Without a shared curriculum, such a conversation would have been unlikely.

An additional support for research lessons may be an ethos that expects, and even honours, borrowing from other teachers. Two Japanese teachers commented on borrowing:

> Even if you copy someone else or are copied by someone else, I don't think anything can be absolutely the same. So, I think it is all right to copy others . . . Our textbooks are very thin with few explanations. The drills only have sets of problems with no explanations. It is up to teachers to decide how to use them. Teachers have to fill the blanks between the lines in the textbook. That is why we have to study about lessons . . . Unless you improve your own skills, you can't do a good lesson even with a good lesson plan or good textbooks. Precisely because of this belief, we all do open lessons and try to improve our teaching skills . . . we show the lessons to each other and critique each other's lessons, or exchange information with others. If you isolate yourself and do whatever you wish to do, I don't think you can ever conduct good lessons.

> If you shoot for originality too early in your development as a teacher, you're likely to fail . . . even though your idea for a lesson was original. Initially, you must take a lot from others. But ultimately, to move to a higher level of teaching, your lesson must become your own original thing, not simply imitation of others. But it's through imitating others' lessons you create your own authentic way of teaching.

*3. Self-critical reflection (*hansei)

Further support for research lessons may come from an emphasis, within Japanese schools and perhaps within Japanese culture more widely, on self-critical reflection (Lewis 1995, Rohlen 1976). Setting goals for self-improvement – by teachers as well as children – is an integral part of Japanese elementary school life (Lewis 1995). Thomas Rohlen has written that 'the Japanese quest for character improvement is close to being a national religion' (Rohlen 1976: 128). Coupled with the strong emphasis on self-evaluation is a strong de-emphasis of external evaluation (such as evaluation by outside examiners, merit reviews, or evaluation of student performance); hence it is safe to reveal one's weaknesses and efforts to improve.

4. Perceptions of national policy

Why did the Japanese teachers we studied try to implement the new, student-centred vision of science education? Why didn't they refuse, or wait for it to pass? Many factors are no doubt important: the slow pace of change may make it hard to wait it out; collaborative schools may make it hard to hide out and stick to one's old practices. Cohen and Spillane (1992: 35) have argued that 'Japanese education may owe as much to deference to authority, habits of accommodation, and extraordinary pressures for cooperation at all levels as to formal guidance'. We are struck both by the truth of this remark and by its converse: Japanese educators' *un*willingness to take

seriously directives they consider highhanded or against their students' best interests. A principal of a local elementary school in a small city near Tokyo told us:

> Every teacher in our school does a research lesson every year. Once per grade level per year we use a commentator from the outside. We are actually supposed to invite in someone from the city office of education, but the teachers won't accept it. So we're really in trouble with the city. There's too much turnover in city office personnel, so we don't call them. It's not the real thing when they do it. They've just been told by someone else what good science education is; they're not experts really.

A teacher at a national elementary school, when asked how the Ministry encouraged adoption of the new approaches to science, said: 'We Japanese teachers are proud – or you could even say perverse (*hesomagari*); you can't force us to do things, so that's not the approach that's usually taken'. Some evidence suggests he is right. Through their collective refusal to administer achievement tests in the 1960s, Japanese teachers successfully prevented the Ministry from ever implementing a planned system of nationwide student achievement testing (Horio and Platzer 1988).

Yet despite their rejection of policies and oversight regarded as detrimental, we have been impressed by Japanese teachers' general willingness to engage ideas like 'initiative', 'problem-solving', and 'desire to learn' that are part of Ministry policy. Teachers may be willing to embrace these goals because they see them as shaped in part by fellow teachers, and as reflecting a relatively broad social consensus – a consensus that might be far more difficult to achieve in the US (Cohen and Spillane 1992). For example, the 19-member committee appointed by Japan's Ministry of Education to revise the *Course of Study* in 1995 included eleven educators (at elementary through university levels), two representatives of PTA, several heads of nonprofit organizations, and several celebrities (including a cartoonist and an actor). Ministry of Education employees were not included on the committee, though they served as staff.

In other words, teachers may not see the Ministry's science education policy primarily as a top-down initiative. As noted earlier, the ideas that eventually become national policy may be formulated and tried by national school teachers for a decade or more, during which time thousands of teachers from across Japan see these ideas in practice during research lessons, and talk about them in the discussions that follow.

Several site-based educators mentioned *their* impact on the Ministry's policies; again, this suggests that policy is not perceived purely as a top-down matter. For example, the vice principal of a national school explained how he succeeded in having the *Course of Study* reworded to talk about studying magnets 'close to' objects rather than 'in contact with' objects. His request was based on his classroom experience (and that of other teachers, described above) that students tended to overgeneralize from electricity to magnetism, missing the idea that magnetic force is transmitted without direct contact. Another teacher explained how his research lesson using solar cells (rather than conventional batteries) led other teachers to teach solar energy before it was included in the course of study; as a result of their grassroots effort, he said, solar energy was incorporated in the *Course of Study*. The extent to which Japanese teachers see national policy as responsive to their own experience and concerns is an important issue for further study.

Whether or not Japanese teachers feel they can influence the *content* of the national curriculum, the generality of the *Course of Study* and subject-specific *Guidelines* leave much room for teachers to determine the style and method of teaching. As one teacher said: 'The government decides the content of education, but the method is left to teachers'.

Conclusion

How have Japanese teachers moved toward student-centred science instruction? We have sketched out three puzzle pieces that we believe to be important to the changes that have occurred. First, the national *Course of Study* and subject *Guidelines* provide broad guidance about educational goals and content; a textbook approval system ensures that textbook content is aligned with these goals, and effectively limits the content teachers feel obligated to cover.

Second, several structures enable teachers to do the difficult, time-consuming work needed to translate abstract national goals – such as 'problem-solving capacity' or 'self-initiated learning' into practice. National school teachers may pioneer this work (long before it becomes national policy), and may disseminate new approaches and ways of thinking via several routes: by conducting public research lessons, visiting local schools as commentators on research lessons, hosting teachers as fellows in the national schools, and publishing their own lesson plans and classroom experiences. Teacher research groups provide a second avenue between policy and practice, where teachers from different schools gather to discuss and try out new ideas, in cycles of repeated collaborative and individual work. A third avenue between policy and practice is research lessons, a ubiquitous feature of life in Japanese elementary schools, and one that asks teachers to relate their own practice to school goals, which in turn relate to larger policy goals. As they plan and conduct research lessons, teachers not only construct a concrete understanding of abstract national goals such as 'problem-solving capacity' and 'autonomous learning', they help each other develop the specific techniques and materials needed to bring these ideas to life in classroom practice.

Finally, we have speculated on the context that supports planned educational change in Japan. Although much more investigation is needed, we have glimpsed a number of beliefs and practices that may provide essential support for planned change: the assumption that change takes time, and that teachers need to reinvent abstract ideas in the real world of the classroom; habits of collaboration and 'borrowing'; self-critical reflection; and a perception that national policy reflects teachers' concerns.

Notes

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2. It should be noted that one student-centred element, student observation of nature, has been part of elementary science education since prior to World War Two.
3. Monbushou. We will use 'Ministry of Education' as a shorthand term to refer to it.
4. Available comparative international data focus largely on mathematics and science.
5. Most of these interviews were conducted in 1995 and 1996. They took place at six different national schools and about 20 local elementary schools. Schools were located in Tokyo, Saitama, Chiba, Niigata, Nara, Nagoya, and Shizuoka. Further details about sample and method are available upon request.
6. Very minor revisions are sometimes published about halfway through the ten-year cycle.
7. All translations of Japanese documents are by the authors.

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