Competencies and Capability Development of Science Teacher in Japan's Teacher Training

—The System and Concrete Image of Teacher Training for Science Teachers—

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Abstract: Science teachers in Japan are working to form and improve their competencies and capabilities through a multilayered expansion of teacher training. This paper provides an overview of the institutional framework for science teacher training in Japan, provides a representative example of research of science classes and the teacher license renewal system, and reveals some concrete examples of science-teacher training.

1. Introduction

"What competencies do teachers need?" When Japan's teachers are asked this question, they are likely to answer in diverse ways: "to excel at lessons," "to lead children and students," "to excel at classroom management." It goes without saying that to help the teachers achieve the competencies they need, going through training stages alone will not complete their education. Rather, the only way to formally improve is through extended lesson practice, continuing in the profession for a long time, and accumulating wisdom through constant study. As the phrase "establishing the image of a constantly learning teacher" (Central Education Council 2012, 2015) expresses, teachers require lifelong professional learning to grow into their specialties and have the vision to respond to the various needs of a changing era and society.

Teacher training plays a vital role in this process. Japan's in-service teacher training has established several training opportunities, including those for science teachers. Teachers who take part in the training are working to form and improve their competencies and capabilities.

This paper draws attention to how science teachers have expanded opportunities for training that helps them improve their competencies and capabilities, provides an overview of the institutional framework, presents several representative examples, and hopes to offer a concrete image of the science-teacher training.

2. The Competencies Required for Science Teachers

As we touched on in the beginning, when we talk about the competencies of (science) teachers, they can cover a multitude of topics. Ohtaka et. al. (2008, 26) mentions the difficulty of limiting those competencies, but for convenience's sake, breaks them down into the following five categories.

① Pedagogical principle competency: Ideas about education, sense of mission, passion, etc.
② Basic practice competency: A teacher who has foundational competency in making lessons.
③ Skillful practice competency: A competency a masterful teacher possesses, high level of practical competency.
④ Pedagogical research competency: Capacity to connect educational practices with research (effective teaching, research into learning strategies, etc.)
⑤ Pure science research competency: specialist research competency with the content to be presented in class.

If any of these competencies are missing, it's difficult to expect a hoped-for outcome in the science lesson. For

example, no matter how much knowledge and skill a teacher possesses about natural science applicable to the classroom (No. 5), if the ability to create a lesson plan and execute it in front of the students (No. 2 and 3), unfortunately good educational results won't be produced. Therefore, it's essential that a competency in each category is balanced well for the potential for improvement. If a science teacher then uses teacher training to further his or her specialization, it can be said that this is the difference between success and failure.

However, it is not always true that just because a teacher participates in different training, which he or she is aiming for thorough improvement in all five competency categories. It's possible that training that would cover all competencies exists, but the aims and stance of typical training will correspond to the person being trained and may place different weight on different competencies. For example, for a teacher in his or her first year on the job, beginner training would probably place the focus on improving categories 1 and 2. On the other hand, training targeting veteran teachers or teachers in management positions would not make those same categories a priority.

Given these sorts of assumptions, a teacher facing training would first need to reflect on his or her own lessons and then grasp the formation of competencies from a meta-point of view. Also, from the viewpoint of that teacher's career, by choosing certain trainings to participate in, the teacher has a better chance for professional growth.

3. Institutional Framework for Science Teacher Training

Teacher training in Japan has expanded in multiple ways via responsible organizations and target trainees (categorized by life stage (duration of service) or job function), embodiment, and implemented content. Moreover, while we can't get into the comprehensive details of each type of training, with the publication of the "Teacher Training Guide 2018" by the National Institute for School Teachers and Staff Development providing a foundation, we can have an overview of the institutional framework for teacher training, including science teachers.

According to the "Teacher Training Guide 2018," as shown in Figure 1, training is mainly from the viewpoint of the place where lessons are implemented and split into three big categories: 1. Self training, 2. In-school training, and 3. Outside of school training. (National Institute for School Teachers and Staff Development, 2018; 2-3).

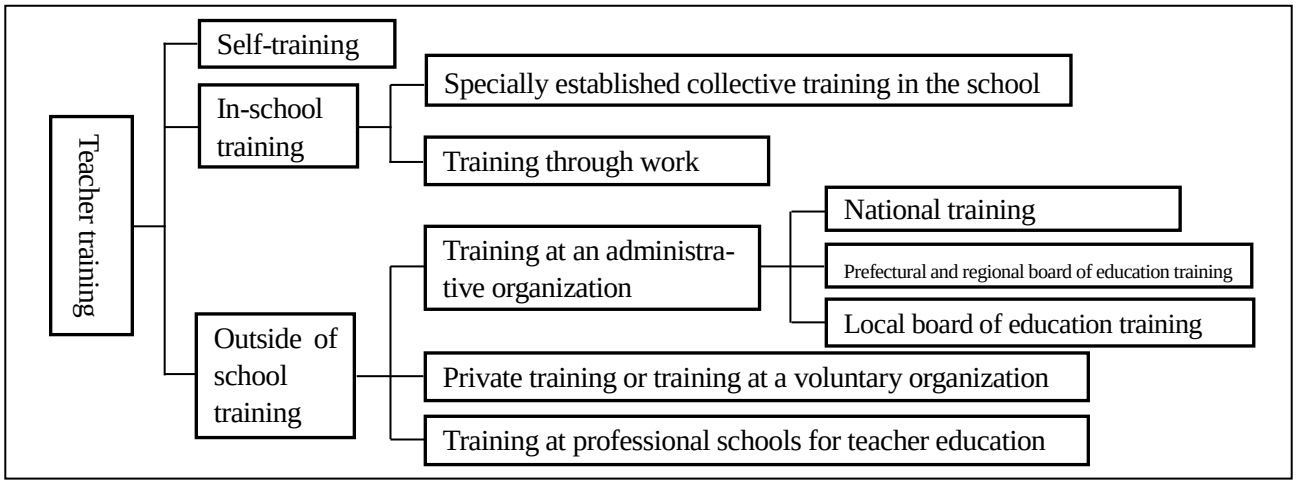

Figure 1 Types of Teacher Training in Japan

(Source: National Institute for School Teachers and Staff Development's "Teacher Training Guide 2018" p.3)

① Self-training

This is autonomous training based on awareness of personal challenges of individual teachers. An involved example for science teachers would be repetition of daily lessons, researching teaching materials, studying science-related journals and literature, participating in different science groups, research groups, circles, etc.

② In-school training

This involves finding solutions to schoolwork and research related to planning and organizing for all teachers. They are categorized as "specially established collective training in the school" and "training for daily school affairs", or so-called "on-the-job training (OJT) ". As far as implementation goes, there are more than a few schools that have research department or research personnel who are in charge of training structure improvement based on grade or subject.

One of the core pillars on training is the lesson study. We will mention this in more detail later, but a lesson demonstration (science class) is typically planned and executed around the main research themes established by the school, and then feedback is offered. This is sometimes done only in the school with an intra-school study conference (with participation from administrators and other teachers from that school). It is also sometimes done with people from outside the school forming a public study conference (with participation from teachers from other schools and other education-related people).

③ Outside of school training

Just as it is written, this is training that takes place away from the school in the field. It is divided into the following three categories:

First, training through an educational administration organization. It's also called administrative training and is often held by a national, prefectural or local board of education. There are many different types, but looking at a prefectural-level board of education training session, there would be legal training for beginning trainees, training for 10-year veterans, and teacher training that corresponds to trainees with 5 years of experience and those with 20 years of experience, student leadership training based on job evaluation, principal and vice-principal training and many other kinds of established training programs. Of course, within this training regimen are sessions for science. Oyama et. al. (2014) took a survey of all the science-related training done in Japan at the prefectural board of education level in fiscal 2012. The results show that about 96% of the training focused on observation and experimentation, and about 79% touched on science-related teaching materials and tools. These are the two main science-related training topics.

Second is private-sector training or training at a voluntary organization. Science, like other subjects, training is held by an associated educational group. One example is the collaboration between Toho University and the Chemical Society of Japan, which has resulted in the Chemistry Experiment Workshop. This training aims to improve practical science teaching and class-making skills. There is also some CSR activity through a company that makes science teaching materials, a practical training group for safe science experiments, and cases where a company forms a practical training group using its own educational materials.

Third one is training at professional schools for teacher education. A professional schools for teacher education offers high-level specialized professional training in a professional graduate school setting. This type of training was formed in 2008. With this training, 1) more practical leadership and development training is offered, with an influential part dedicated to new teacher training for building up a new education style, 2) and for regional or school teachers (core mid-career teachers) looking to take on leadership roles, indispensable teaching theories and very

practical and applicable training sessions promote skill leaders. When it comes to in-service teacher training, the training offered in 2) is especially important. The point is to offer practical leadership methods across five subject areas. With each separate subject, school training and the curriculum develop high-level practical leadership skills.

Also, this isn't show in Figure 1, but it is regarded that the start of a teacher license renewal system in 2009 had a wide impact on teacher training. Under this system, teacher certifications last 10 years, and when it comes time for renewal, another 30 hours of further license training is required. The newly required training is held at universities accredited by the Minister of Culture, Sports, Science and Technology. There are quite a few options for science-related training within these courses.

That completes the outline of the institutional framework for teacher training. Of course, the presentation we made here and the training sectors we highlighted are just examples, and some training doesn't fit into any one category. For example, we earlier mentioned beginners' training, which, in addition to being held at prefectural education centers, also comes with a requirement of 300 hours of in-school training, making it a combination of out-of-school and in-school training experiences. At any rate, we would like to make it clear that there are many types of teacher training sessions available in Japan.

4. A Concrete Image of Science Teacher Training

There are many organizations established to further training for science teachers and teachers of other subjects, but what are the detailed contents and paths of progress for that training? Here, we would like to focus on the science lesson study and the teacher license renewal system implemented for science teachers almost 10 years ago and take a closer look.

(1) Science lesson study

Japan's lesson study is spreading around the world and attracting a lot of attention (National Association for the Study of Educational Methods, 2009; i). Among Japanese teachers, there is no doubt that everyone is familiar with these activities. Lesson study conferences hold many training sessions both within and outside of schools.

Here is an outline in Figure 2 of the basic structure of a science lesson study conference and one example of the flow (Source: created based on Ohtaka, 2012; 6-7, Isozaki, 2014; 27-29). Let's take a closer look while depending on Ohtaka (2012) and Isozaki (2014).

First, during the preparation stage for a lesson study conference, based on the main subjects of the entire school and the research theme set for each subject accordingly, the teacher of the lesson study facilitates the discussion to design and review the science lesson plan. In the lesson plan, the goals of entire unit, the lesson position in the unit, the teaching materials to be dealt with, the learning situation of the students in the classroom, the subject to be taught, answers by the students to the teacher's questions and expectations, detailed learning activities (including viewpoint and experience), ways for the teacher to assist and support, and viewpoints and methods for evaluating student learning must be carefully written down. At the same time, teaching material is being developed (including observations, experimental activity). Participants in a lesson study are very interested in what sort of teaching material will be used, and what sort of observations and experimental activities will be done, which gives the teacher a chance to show his or her skills. Furthermore, it is not uncommon at this preparation stage for other teachers or outside university professors, teacher's consultants to offer advice, and for teachers to use other classes as trials for improvement based on the lesson plan.

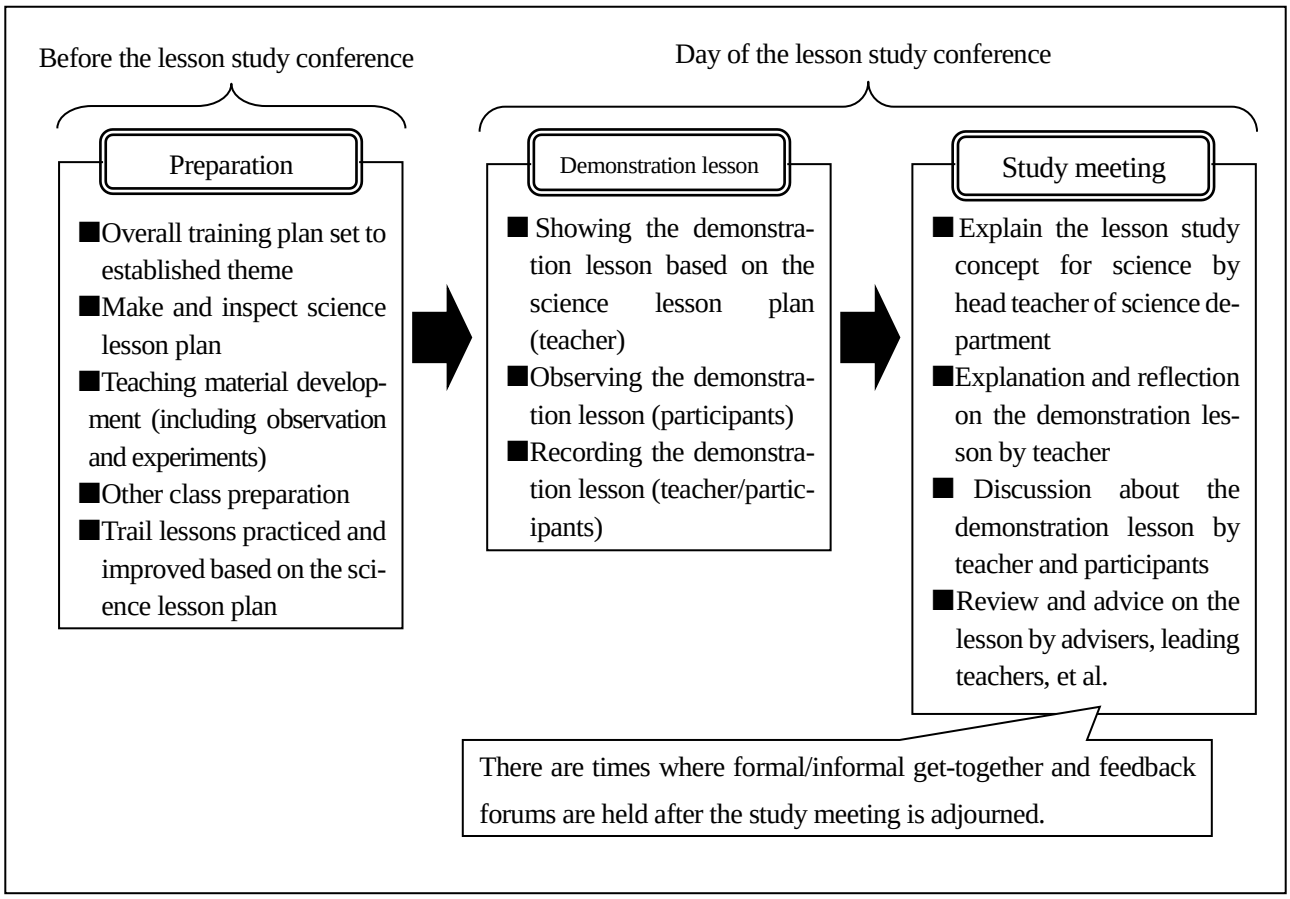

Figure 2　The Basic Structure of a Science Lesson Study Conference

(Source: created based on Ohtaka, 2012; 6-7, Isozaki, 2014; 27-29)

Through this sort of preparation, the day of the lesson study conference draws near. In a lesson study conference at an outside location, there are also cases where, before the lesson study, an effort is made to explain to the participants the overall training subjects of the school in a "plenary session." All participants are given handouts of lesson plan and they all go to observe the demonstration lesson. Participants may examine how the written contents of the lesson plan align with the actual developments in class while observing the class. Sometimes fellow teachers or the teacher doing the lesson study may video the class, so that it can be repeated with the study meeting later.

When the demonstration lesson is over, the teacher and participants continue to get together as the study meeting is held. At the study meeting, first the head teacher of science department will explain the concept of the lesson study, then the teacher who show the demonstration lesson will explain his or her aims and points of emphasis for the class and will reflect on the class. Then, a meeting is held with participants. The way of proceeding a meeting varies depending on a case. The participants and teacher have an open discussion and exchanging opinions at times, or breaking into small groups to go over the teaching material and class observations after which a representative from each group presents their findings to everyone. Finally, an adviser (university professor, teacher's consultant, or administrator) evaluates and offers advice for the lesson study. Also, there are sometimes formal or informal gatherings and get-togethers after the study meeting to continue critiques. These occurrences may include information exchanges and discussions beyond the framework of the lesson study. However, in recent years, we've seen a decline of these get-togethers.

There have certainly been problems for these types of science lesson studies when discussions and questions have been weak (Ohtaka, 2012; 8). Even so, it is fair to say that they have been indispensable for forming and improving science teacher's structural and practical competencies.

(2) How Science Teachers are Training under the Teacher License Renewal System

As mentioned earlier, the teacher license renewal system is a relatively new system for more than 10 years after introduction. As of 2018, 556 universities, junior colleges and boards of education across the country had been accredited by the Ministry of Culture, Sports, Science and Technology. When it comes time for renewal, the training a teacher must take is divided into required subjects (6 hour or more), elective and required subjects (6 hours or more), and elective subjects (18 hours or more). Science-related training sessions are almost all under the elective category.

What sort of training is actually held and performed? Table 1 compiles one section of the science training sessions held at the University of Tsukuba in 2018. There is a wide variety of training sessions from how to plan a science class to teaching methods, developing teaching materials, observations and experiments in field work, new scientific research, training sessions for university affiliated schools. For example, in "A lesson for children who like science," a science class is built based on problems Japanese students face with science when compared to other international students, points about new ways to teach science, recent educational theories, learning achievements are evaluated, and a deeper structural understanding of science education is gained mainly from the viewpoint of subject education.

Also, if we look at the subjects of the teachers' classes, there is some variation, and most classes offer a wide interpretation. Given that the training is done in spans of 10 years for new licenses, it is probable that the teachers span three generations. Because of this, the school subjects and teaching experiences of the fellow teachers brought to bear on one class offers an opportunity for mutual exchange of opinions and viewpoints that may differ from one's usual way of thinking, perhaps sparking new ways of thinking. On the other hand, from the teacher's perspective, while performing the class in front of others, depending on what subject is chosen, what generation is emphasizing the points, trouble may arise, and those taking the class may not get the results they were expecting. This is probably not only true during the license renewal process, but when receiving the training of a selected type, it is important to consider the competencies needed for the teacher's current situation and life stage and make the training commensurate with those indicators. Also, the lecturer must consider the students' conditions and needs when inspecting the detailed training content. Training that enhances both points of view holds the key.

Table 1　Example of Science Related Teacher License Renewal Training at University of Tsukuba in 2018 Fiscal Year

Training name	Target									
	Kindergarten	Elementary school	Middle school	Mandatory education school	High school	six-year secondary school	special support education school	Childcare-related certification Children's Garden	Nursing teacher	Nutrition teacher
A lesson for children who like science	○	○	○	○	○	○	○	○		
Understanding radiation ~The basics and principles of radiation~	○	○	○	○	○	○	○	○	○	○
Bouncy ball lecture		○	○	○	○	○				
Energy sources and new technology		○	○	○	○	○				
Technology that supports AI and Big Data			○		○	○				
Playful experiments, interesting work	○	○	○	○	○	○	○	○		
Discovered! Mt. Tsukuba area geopark	○	○	○	○	○	○				
Talking about rice plants and rice	○	○	○	○	○	○	○			○
Moving earth ~earthquakes・tsunami・eruptions・landslides~		○	○	○	○	○	○			
The Satoyama expedition	○	○	○	○	○	○	○	○		
Aiming for durable and delicious vegetables ~Field trip to the Institute for Horticultural Plant Breeding~	○	○	○	○	○	○	○	○		
Outdoor observations at a museum park ~Let's look up the names of the nearby plants and moss~	○	○	○	○	○	○	○	○		
Animal observations ~Observing daphnia and a story about bears~	○	○	○	○	○	○	○	○		
University affiliated elementary school training		○	○	○			○			
University affiliated middle school training		○	○	○	○	○	○			
University affiliated high school training			○		○	○	○			

5. Conclusion

The professional development of science teachers calls for a lifetime of continuous development above and beyond the actual work. It goes without saying that attending one or two training sessions does not mean overnight success. At the same time, teacher training for science teachers is an important piece of their formation of competency and professional growth. That will not and has not changed. As you've come to see in this paper, Japan's teacher training is manifold, and many training opportunities are available for science teachers.

However, this teacher training is not without its problems. For example, if we look at the results of the OECD's 2013 Teaching and Learning International Survey (TALIS), while motivation for training among Japanese teachers is high, the biggest barriers are trying to fit training sessions into busy work schedules (National Institute for Educational Policy Research, 2015; 128-129). When this information is considered, both the opportunity for training and for content enrichment as well as making an environment where it is easier for teachers to participate should be discussed as possible reforms to consider.

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