Inspecting Proactive Methods for Improving Competencies and Capabilities of Japan's Science Teachers through Teacher Training

—Practical Examples as the Foundation for Themed Research into Science Teacher Training—

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[Abstract] We inspected practical examples as the foundation for themed research into science teacher training, so that teachers could embody the image of the spirit of the continuously learning teacher through proactive methods for forming and improving their competencies and capabilities. Through three specific examples of unique themed research, it is suggested that teachers can proactively form and improve their competencies and capabilities. The first is when the teacher chooses his or her own theme and forms the voluntary training in the school, outside of the school, and on their own. The second is through various ways such as observing video of your class, trial lessons, and demonstration lessons, and each time the lesson study was conducted. The third is when the trainer cooperatively works to pick a theme for the research.

1. Introduction

With our country's teaching policies, the most important issue is to form and improve competencies and capabilities of teachers, so that they can continue their inquiry and embody the image of continuing their education. (The Central Education Council, 2015)

The abilities that teachers need are universal ones as well as ones that correspond to the era's changes. The former includes, for example, a sense of mission and responsibility toward teaching, a love for education, professional knowledge that relates to subjects and teaching, practical teaching skills and attributes that make the teacher a full person. (The Central Education Council, 2012) The latter includes the strength to be a teacher in a drastically changing society.

In the report of 2015 by the Central Education Council, "How to improve the abilities of teachers in future school education" highlights the various capabilities a teacher will need in the era to come. Among the capabilities listed as necessary and especially important in a changing era are "the desire to continue learning, and the ability and knowledge to gather, sort, and use information to organize in an organic way."

There are many forms of teacher training available to Japan's teachers, so that they may embody the image of a continually learning teacher and continue to improve their abilities. However, it is important to create an environment where teachers are motivated to continue training and when, in their busy schedule, they can find the time. In order to solve these problems, the Ministry of Education, Culture, Sports, Science, and Technology used proactive reforms to promote a systemized teacher training program at prefectural and local levels. (The Central Education Council, 2015).

How much can teachers raise their awareness about the need to continue learning and proactively improve their capabilities, while trying to avail themselves of teacher training opportunities in their busy lives? In this paper, we considered how detailed science teacher training examples show a path for teachers to embody the image of continuing education and proactively improve their capabilities through training.

2. Capabilities Needed by Science Teachers

We mentioned earlier the capabilities needed by teachers, but what are the capabilities needed by science teachers? Ohtaka (2008) discussed the difficulty of categorizing teacher competencies before breaking down the competencies needed by science teachers into five categories.

1) Pedagogical principle competency: ideas about education that support and form the basis for the teacher's competencies, as well as sense of mission, passion, etc.
2) Basic practice competency: A self-reliant teacher who has basic competency to make educational practice possible. A competency that focuses on the school's teacher training and beginner training.
3) Skillful practice competency: A competency held by accomplished teachers through experience, accumulated training and a high level of practical competency.
4) Pedagogical research competency: Competency to connect educational practices to research.
5) Pure science research competency: Specialist research competency with the content to be presented in class.

These five competencies, taken on their own, don't add up to effective educational tools. According to Ohtaka (2018a): 1) Pedagogical principle competency alone doesn't allow for practical education practices; 2) Basic practice competency alone limits the ability to fruitfully handle the many problems faced in today's educational practices; 3) Having a skillful practice competency, the immediate educational effect is apparent, but empiricism alone makes it difficult to form a basis for educational improvement; 4) With pedagogical research competency alone, or in other words, theoretical knowledge of science education alone, one cannot keep up with the multitude of educational practices today; and 5) pure science research competency alone, in other words, specialist research competency alone do not guarantee a full educational practice.

As earlier mentioned in the Central Education Council's report (2012, 2015), these five main competencies can be said to equal the universal qualities needed for a teacher. However, core competencies concerning foundational issues and elements of mastery require new abilities because of societal changes. Also new abilities are required for educational research and pure science research, so that research in certain specialized sections can progress. Thus, science teachers need to include these new competencies into their five immutable competencies. It is vital for science teachers to balance these five core competencies while improving their competencies and capabilities.

3. Practicalities of Teacher Training Improving Science Teacher Capabilities

In Japan, there are various kinds of teacher training, starting with the educational centers at the prefectural level. To improve teaching skills for a new age, new sorts of training content and forms such as improving classes from the point of view of Active Learning will become necessary. If we review the current structure for science teacher training, it's not only about finding new content and forms, but about making the existing training more proactive in improving teacher capabilities. That is the sort of themed research where the teachers decide on the themes themselves (abbreviated as "themed research" below). A science teacher themed research is research that cultivates a subjective and practical attitude toward a theme of interest to the science lesson. Of the five competencies mentioned earlier, the most effect would be had on 3) Skillful practice competency; 4) pedagogical research competency; and 5) pure science research competency. Much themed research has a longer span of a year to complete. How does this themed research fit into the various teacher training programs? How will they be practiced? The type of teacher training and the life stage of the teachers must be reflected in the training. Next,

let's look at where themed research fits and some detailed examples of themed research.

1) Types of Science Teacher Training

The Faculty Guide 2018 published by the National Institute for School Teachers and Staff Development lists the types of teacher training in Japan (Figure 1). The types were compiled from the places hosting the training and are divided into three big categories: self-training, in-school training, and training outside of school.

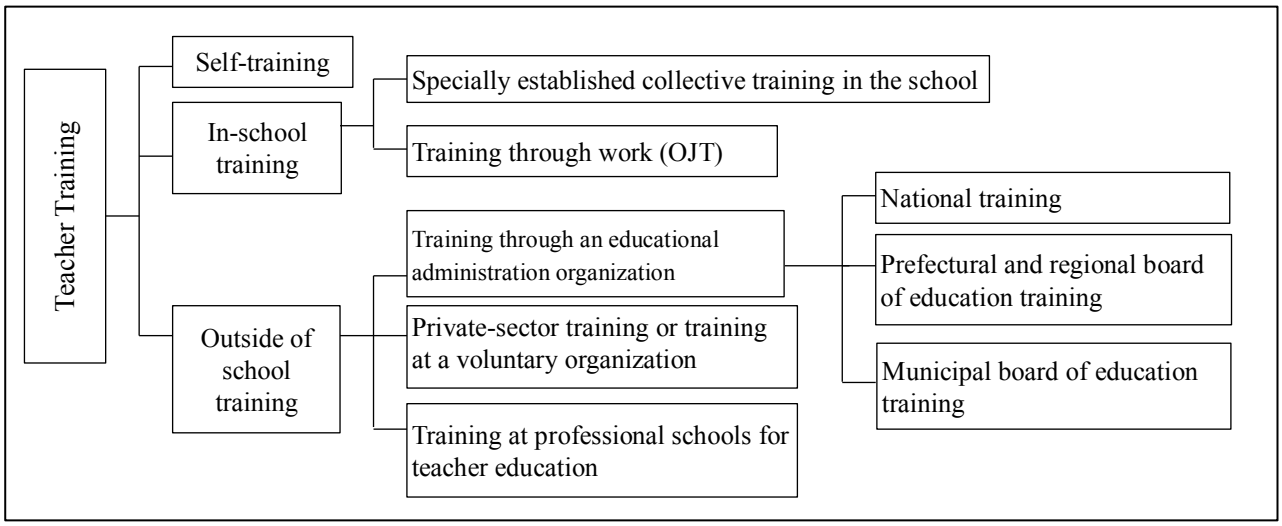

Figure 1 Types of Teacher Training in Japan

(Source: National Institute for School Teachers and Staff Development's "Teacher Training Guide 2018", 2018, p3)

With self-training, the teacher does individual training on his or her own. With in-school training, the training is done at the school that employs the teacher. That sort of training is divided into specially established collective training and on-the-job training at the school. Training outside of the school is mostly held somewhere other than the school and is divided into three categories: training through an educational administration organization, private-sector training or training at a voluntary organization, and training at professional schools for teacher education.

However, training held by an educational administration organization could be categorized as both outside and inside the school. For example, with beginner training (where newly hired teachers are trained after a year on classes, materials, and subjects they are in charge of) teachers must engage in at least 25 hours of training per year outside of the school and 300 hours of in-school training per year (The Ministry of Education, Culture, Sports, Science, and Technology, 2019 access). Themed research for science teachers differs by prefecture, but it is often incorporated into the training that is required during the year, such as the beginning training. The Faculty Guide 2018 referred to earlier explains the themed research training.

2) Science Training Established by Life Stage

The information on Figure 1 was compiled from the places hosting the training. The training is sorted by the life stages of the teachers. One example is Teacher Y who spent 13 years at X prefectural high school receives

long-term teacher training suitable to the teacher's life stage. Y went to the X prefecture educational center for beginner training in 2001 and has taken science teacher training courses 10 times. The training has mainly consisted of themed research. Furthermore, Teacher Y has used her teaching experience to engage in many short science training sessions outside of the typical teacher training.

Table 1 Teacher Y's Long-term (1 year) Teacher Training through the National Prefectural Board of Education (2001-2013)

Years of Experience	Training Outside of School	Science Teacher Training
First year	Beginner training (legal training) (28 times + volunteer activity training)	Themed research (10 times)
Fifth year	5th year teacher training (training based on teaching experience) (5 times＋societal experience training)	Youth science museum in T city societal experience training (1 time: 5 days)
7th year	Special teacher training at X prefectural center (25 times)	Themed research (16 times)
10th year	10th year teacher training (legal training) (10times)	Themed research (6 times)

In Table 1, the beginner training and 10-year training in principle are required legal training for all teachers. In X prefecture in 2005, high school teachers also had a 5-year training. X prefecture established the special teacher training at the X prefecture educational training center to nurture people who could take on leadership qualities at local schools and in other areas, and to raise the level of teaching material and leadership qualities, through lesson plans. This training was targeted at teachers with five or more years of experience in principle. In this example, where the 16 science training themed research sessions were completed as part of the 25 training sessions needed outside of the school, Teacher Y with 13 years of experience did made the most effort with the themed research. The content and analysis of the special themed research teacher training taken on by Teacher Y is included in this paper.

3) Example of Themed Research in Science Teacher Training

Teacher Y spent fiscal 2007 (April 2017 through March 2018) doing special teacher training at the X prefectural education center. Science teacher training was folded into the overall training. The contents of the 16 science teacher training sessions are shown in Table 2, and all together they made up the themed research. The lead for the themed research was taken by the high school science teaching consultant of the X prefectural education center (hereinafter referred to as "teaching consultant"). Teacher Y (high school biology teacher) was joined in the training by two other teachers, Teacher B (high school biology teacher) and Teacher C (high school chemistry teacher) (hereinafter referred to as "trainees"). The theme of Teacher Y for this science teacher training was "Tools to enhance integration of instruction and evaluation in Integrated Science B—introducing the one page portfolio assessment."

Table 2 Special Teacher Training in Science-themed Research Received by Teacher Y at X Prefectural Education Center (fiscal 2007)

Session	Time	Contents of Science Teacher Training
1	mid April	Understanding and working toward solving the issues for improving lessons
2	late May	Analyzing in detail the policies for improving lessons, observing video of your class and lesson study
3	mid June	Report on the progress in improving lessons, detailed analysis of policies
4	late June	Report on the progress in improving lessons, detailed analysis of policies
5	early July	Decide on research theme for improving lessons, analyze and report on progress for improving lessons
6	mid July	The fruits of improvement based on this training, and announcement and confirmation of the plan for themed research
7	early August	Progress in themed research, report on self-training during summer vacation, literature survey for themed research
8	late August	Practice of trial class and lesson study
9	early September	Report and analysis of progress in themed research
10	mid October	Creation and submission of (mid-term) report on this training
11	late October	Observe class by accomplished biology teacher D
12	early November	Observe demonstration lessons and lesson study by Trainee C (chemistry teacher)
13	mid November	Perform Teacher Y's demonstration lessons and lesson study
14	late November	Report and analysis of progress of themed research
15	mid December	Observe demonstration lessons and lesson study of Trainee B (biology teacher)
16	January	Finish themed research, create and submit report

We will explain the contents of the various training sessions listed in Table 2. The first session was about understanding and working to solve the issues around improving lessons. In detail, each trainee thought about the issues they face during lessons at their school, then they listed up ways to solve those issues. The trainees then collaborated and focused on those issues with the support by the teaching consultant.

In the second session, detailed policies toward improving lessons were analyzed, and lessons by each trainee were recorded and observed, and lesson study was conducted. In Teacher Y's case, on the advice of the teaching consultant, she improved class by using one page portfolio in the "Integrated Science B" based on her school and her students. The portfolio was developed in 2002 by Hori. In it, the teacher recorded the aims for his or her study and listed on a sheet the scholastic records before, during and after the study (Hori, 2004). The sheet used for the one page portfolio assessment is called the one page portfolio, and abbreviated as OPP.

During the second day, the teachers had all recorded a regular class at their school. They were observed as part of training and used for the basis of lesson study. The lesson study has the aim of developing a teacher's profession and professional competencies. To do this, an actual class is targeted and analyzed, and the research is meant to develop professional competencies (The National Association for the Study of Educational Methods, NASEM, 2009). Japan's lesson study is attracting international attention and being highly evaluated. It is likely to spread around the globe.

The third session includes a progress report on lesson improvements and an analysis of the detailed policies to

be used hereafter. In teacher Y's case, she created the OPP used in her lesson, received feedback from the teaching consultant and other trainees, and made improvements.

The fourth session also consisted of a progress report on lesson improvements and an analysis of the detailed policies to be used hereafter.

The fifth session was based on the lesson improvements made so far, and each trainee established her theme for the themed research on lesson improvements. Teacher Y's theme was "Making a lesson that builds student interest and engagement through the one page portfolio."

The sixth session reviewed the science teacher training of the past four months and confirmed the direction of each person's self-training. In Teacher Y's case, she brought the benefits listed by students in the OPP, showed them to the teaching consultant and other trainees, and was given advice.

In the seventh session, a report on the progress of the themed research and plans for self-training over summer vacation was submitted. Also, a literature survey for the themed research was conducted. Teacher Y reported on different training (environmental training conducted by the X prefectural education center) she participated in during summer vacation and did the OPP literature survey.

In the eighth session, the trainees each did a trial lesson and lesson study on their themed research. Teacher Y used the OPP and conducted a trial lesson on the biological evolution for Integrated Science B. For the class, her distributed to the other trainees a lesson guide, which was used as analytical material in the lesson study after the class.

In the ninth session, a report and analysis of progress in the themed research were conducted. In September, the second semester started, and trainees confirmed their detailed plans for lesson improvement. Teacher Y received advice from the teaching consultant on using the OPP to bring about detailed improvements.

In the tenth session, an interim report (mid-term training progress report) about this training was created and submitted. Each trainee reconfirmed the reasons for their themed research and the steps and analysis methods employed to achieve lesson improvements.

In the eleventh session, they went to S public high school in X prefecture and observed the biology class done by the accomplished Teacher D (dissecting a chicken). After the class, the trainees wrote down their impressions from the viewpoint of improving their own classes and submitted them to the teacher.

In the twelfth session, they went to T public high school in X prefecture to observe trainee C's trial lesson and lesson study.

In the thirteenth session, Teacher Y used the OPP in her trial class and lesson study at her school. She created a teaching guide which became material for her demonstration lessons and lesson study. In the demonstration lessons and lesson study, the teaching consultant, other trainees and other science teachers from Y's school offered advice on how to improve the lesson.

In the fourteenth session, a report and analysis of the progress of the themed research were conducted. In Teacher Y's case, the content of her new OPP unit was analyzed.

In the fifteenth session, they went to M public high school in X prefecture to observe trainee B's demonstration lessons and conduct the lesson study.

In the sixteenth session, each trainee concluded their themed research. In detail, they summarized the reasons for their themed research, plans for improving lessons, daily detailed practices, and the achievements of the demonstration lessons and lesson study exercises. Then they discussed with the teaching consultant and fellow

trainees.

That concludes the introduction of the teacher training content this time. Three points about the overall training and characteristics of the themed research are mentioned here. First, the training took on a combined form with the themed research selected by the each trainee, with training at the comprehensive educational center, actual practice of the themed research at in-school training, literature surveys that were conducted within and outside the school and self-training. The second is that each trainee was observed in different ways through recordings of classes, trial classes, and demonstration lessons. These all resulted in time being spent on the lesson study. The third point is that the trainees collaborated on ways to improve their lessons and each time exchanged opinions. Though their research themes were all different, they worked together on lesson improvements. The teaching consultant gave advice on lesson improvement strategies when appropriate. Teacher Y was able to spend a year on the subject of science teacher training within her unique themed research. After this teacher training was finished, Teacher Y taught using her OPP to improve her lessons continuously until he retired six years later. This is a unique example and analysis of a science teacher, but it is also an example of how teacher training allows for a person to improve his or her capabilities and competencies in a core subject.

4. Conclusion

In this paper, we introduced and analyzed how teachers could continue to embody the spirit of the continuously learning teacher, and aim to improve their core competencies and capabilities in their subject matter through teacher training by focusing on examples of science teacher training, a part of the existing trainings conducted over a long time, and especially themed research. It is difficult to provide the time and motivation for teacher training like this themed research that is done on one's own. However, it is thought that if efforts are made to improve lessons and deal with your issues in beginner training and other periodic required training based on experience that offers themed research opportunities, you will improve your main competencies and capabilities as a teacher. It is anticipated that if, like Teacher Y, you can match a research theme to your educational practice, you can raise your awareness of continued training.

This sort of themed research is conducted over a long time. One line of thinking is that the pressure of doing lessons at one's school puts a big burden on the trainee. However, with regards to revisions in curriculum guidelines, great emphasis has been placed on the process of inquiry and research activities with regards to science (Ministry of Education, Culture, Sports, Science and Technology, 2017). It can be said that they form the core of the new curriculum guidelines (Ohtaka, 2018b). And, if we are to expect young students to conduct their inquiry independently, we must elevate the abilities of the science teachers tasked with their education. For teachers to maintain a constant spirit of curiosity to promote their own learning, the most effective policy is for the teachers to actively take advantage of research opportunities that explore science teacher training, which helps them to proactively identify the issues and make improvements in the practical aspects of education.

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