A DEVELOPMENT OF TEACHER TRAINING PROGRAM COMBINED WITH GEOLOGICAL FIELD OBSERVATION AND EXPERIMENTS AT OUTCROPS ON LAKE BIWA, SHIGA PREFECTURE, CENTRAL JAPAN

Kazuhiro Sawada¹, Mamoru Murata²

¹ Joint Graduate School (Ph.D. Program) on Science Education, Hyogo University of Teacher Education (JAPAN)
² Naruto University of Education (JAPAN)

Abstract

Japanese elementary and lower secondary school teachers are still facing many difficulties to teach the field observations designated by the Government of Japan Course Guidelines, the Ministry of Education, Culture, Sports, Science and Technology in 2008. This is caused by their poor experience and practical knowledge of the subjects. In order to solve the problems and to make their teaching more practical, we initiated and have been revising a teacher training program since 2014, which covers not only oral explanation but also in situ experiments on the phenomena observed on the outcrops. On the basis of their deficit knowledge and the requirement for them to be able to undertake basic observations, the connection of outcrops and landscape with human life, history and industries is arranged, therefore we sorted out two rivers, Chinai and Momose rivers, on western shore area of Lake Biwa, Shiga prefecture, central Japan. The Chinai river in north and the Momose river in South occur at a distance of 0.5 km in the estuary and 6 km in the upper stream, respectively. The Chinai river originated in granitic rocks yields chestnut in the alluvium fan and swimming beach with white sand on the shore. The Momose river originated in sedimentary rocks yields persimmon in the fan and dark beach where no one swims. At the outcrops in upper, middle and lower streams of the rivers, not only explanation but also experiments on the phenomena observed on outcrops were performed. The in situ experiments were the classification of grain size of sediments with sieve analysis, strata in plastic bottle, and the weathering of granitic rocks. The participants of the training learned the basic concept of discussing an outcrop. They were impressed by the experiments and gave this program good evaluation report. The result of pre- and post-questionnaire showed that the teachers conquered the difficulty in teaching the subject in Earth Sciences and the field observations.

Keywords: teacher education and training, geological field observation, in situ experiments, outcrops.

1 INTRODUCTION

It is the most difficult for elementary and junior high school teachers to teach subjects in the Earth Sciences due to their poor practical knowledge of the subjects. The field geological observation has been designated compulsory by the Government of Japan Course Guidelines, the Ministry of Education, Culture, Sports, Science and Technology since 2006. However, many teachers had no experience of the field observation. As some trainings of the field observation were performed by only lecture on the outcrops, the teachers could not link the knowledge by lecture and the observation. This was because the geological specialists, staff of university and museum, did not know what the teachers did not know. And as the geological units, strata and rocks in the field observation, were different from those in their school areas, they could not perform the same subjects as what they learned at the training. The school teacher who knows geology better by the experience for geological survey should teach other teachers the universal and fundamental geological concept such as the erosion, transportation and sedimentation. The participants in such in-service training can ask any questions without hesitation because the instructor is one of their colleagues. The instructor can also answer easily with its experience what it failed in understanding for geological field observation. Moreover the experiments on the outcrops would make the participants how what they observed was formed understanding easily.

We developed a teacher education and training program in Earth Sciences combined with how to observe outcrops and in situ experiments for elementary and junior high school teachers, on which a
junior high school teacher as an instructor lecture to colleagues voluntarily. The practice in 2014 was highly satisfied by the teachers, but we have been revising it and introduce a part of the activity.

2 TEACHER EDUCATION AND TRAINING IN JAPAN

2.1 Purpose

The education in Japan has been controlled by the Basic Act on Education since 1947. The Article 6(School Education) in the Act No. 25 of 1947 described the followings. (1)The schools prescribed by law shall be of a public nature and, besides the national and local governments, only juridical persons prescribed by law shall be entitled to establish them. (2)Teachers of the schools prescribed by law shall be servants of the whole community. They shall be conscious of their mission and endeavor to discharge their duties. For this purpose, the status of teachers shall be respected and their fair and appropriate treatment shall be guaranteed. And it was revised in 2006 and the Article 9(Teachers) in the Act No.120, 2006 related the followings. (1)Teachers of the schools prescribed by law shall endeavor to fulfill their duties, while bearing deeply conscious of their noble mission and continuously devoting themselves to research and self-cultivation. (2)Considering the Importance of the mission and duties of the teachers set forth in the preceding paragraph, the status of teachers shall be respected, their fair and appropriate treatment ensured, and measures shall be taken to improve their education and training. The improvement of teacher education and training had been performed before 2006, but more activities were also regulated after the Act was revised.

2.2 Measures of teacher education and training

The teacher education and training guaranteed by the Act is divided into two groups; paid and unpaid. The paid teacher education and training is sub-divided into duties and applications in office hours. The paid duties teacher education and training is performed as in house, fresh teachers, every 10 years, renewal teacher license, specified by the board of education or educational center in prefecture, and individual subjects by the teacher associations of each subjects. The results are often performed as open lectures. The paid applications teacher education and training is served by the academic associations, universities and museums.

The paid teacher education and training is controlled by the governmental top-down system, but the unpaid one is volunteered by the bottom-up system of teachers. The unpaid teacher education and training is performed out of office hours, Saturday, Sunday, or national holidays. The lecturer and attendants do not get financial supports by government.

2.3 Practice of unpaid teacher education and training

The first field observation course for the erosion, transportation and sedimentation by rivers was held on 23rd, November 2014, Saturday and National holiday, as an unpaid teacher education and training. The lecturer was one of the authors (KS) and an assistant in excursion was a high school teacher. Seventeen teachers (6 primary and 11 junior high school teachers) attended it. In the questionnaire ten attendants knew the excursion by direct announcement, five by call of colleague, and five by leaflet. The questionnaire is marked by six categories; strongly agree, moderately agree, agree a little, disagree a little, moderately disagree, and strongly disagree least. In answer to the question “Do you need a volunteer training?”, fifteen marked “strongly agree” and one “moderately agree” in the questionnaire. The teachers are conscious of the need of self-cultivation and attended many teacher education and training, but one marked “strongly agree”, six “moderately agree”, six “agree a little”, one “disagree a little”, two “moderately disagree” and one “strongly disagree” to the question “Are you anxious to how to observe the strata and sedimentation?” Thirteen of seventeen teachers are anxious to geological field observation and consider that they would not teach students the observation well, although it is one of the compulsory subjects in primary and junior high schools.

3 A DEVELOPMENT OF THE FIELD OBSERVATION COURSE FOR THE EROSION, TRANSPORTATION AND SEDIMENTATION BY RIVERS

The results of questionnaires for school teachers show that the geosciences subjects are very hard for teaching due to less knowledge and poor experience of field geological observation. The erosion, transportation and sedimentation by rivers are studied in primary and junior high schools in Japan.
Moreover, the Ministry of Education, Culture, Sports, Science and Technology has set a framework of field observation for students since 2012. However, the teachers are still anxious about how to teach students the subject such as deposition of sediments and observation of the subsequently formed strata. To solve these problems, we develop a teacher training program which consists of one day excursion and in situ experiments to know topology, industry and human life, depending on the erosion, transportation and sedimentation by rivers and to study how to observe the strata caused by the process of sedimentation.

The excursion course is developed for Takashima, the western side of Lake Biwa, Shiga prefecture, central Japan (Fig. 1). The region consists of Jurassic sedimentary rocks, Paleogene granitic rocks and their alluvial fan deposits and estuarine sediments. The older to younger geological units crop out from the upper to lower reaches of the rivers. As the Momose-river runs in sedimentary rocks and the Chinai-river runs in granitic rocks, the difference topology caused by the differential erosion and color of estuarine sediments reflected by sedimentary and granitic rocks can easily be observed. For human life, persimmon trees are planted in alluvial fan deposits of the Momose-river and chestnut trees are planted of the Chinai-river.

### 3.1 Stop A

The V-shaped valleys in mountains are observed. The Arihara complex[2] is composed of grayish siliceous silt rock, grayish chert and dark gray siliceous pelitic rocks from lower (South) to upper (North). The Momose-river erodes and transports its clastic materials due to high speed streams in the mountains.

### 3.2 Stop B

The Momose-river reaches at the foot of the mountain and decreases its speed, and then deposits coarse grains and makes alluvial fan. The fan deposits mainly consist of pelletic pebble, gravel, sand and silt. The fans have high permeability due to coarse grain deposits and make high quality
persimmon. The underflow channels flow out at the end of the fans, where people have been living from ancient times.

In situ experiment is performed at the Stop B. The comparison of fan deposits and the Wentworth grade scale makes the definition of the grain size clear. The teachers could classify the soil with the scale. The formation of fan deposit is explained by the function between grain size and flow speed with the Hjulstroem diagram, which is taught in junior high school. When the teachers see the topology, they can observe the grain size of fan deposits with the Wentworth grade scale and interpret the formation of fan with the Hjulstroem diagram. And a new experiment, strata in plastic bottle, has been added since 2015. The participants put gravels, sands and silts in plastic bottles with polyvinyl alcohol and water due to higher viscosity than water, shake and put on the ground. The grading, finer grains in upper and coarser ones in bottom, in the strata by Stokes law can be easily observed. Consequently, they can understand how to observe the field phenomena.

3.3 Stop C

The meaning of "Momo-se" in Japanese of the Momose-river is “hundred-shoal”, which shows many flood and flood plain deposits. As the river making fan deposits transported much pebble and sand, people made banks, which caused river level high and promoted more sedimentation. The piracy from the Ishida-river was caused by the upheaval of Nosaka mountains, and supplied much sediments to the Momose-river, and then made it the raised bed river. Fig. 2 shows a tunnel, where the Momose-river runs the upper and the road crosses the below. The river level is over ca 6m from the road.

![Figure 2. The crossover of the Momose-river, raised bed river, and road.](image)

3.4 Stop D

The terrace and alluvial fan deposits of the Chinai-river, which runs in Paleogene Koujyaku granitic rocks, are well developed. The granitic rocks are of medium grained biotite granite, which changes gradually coarse grained biotite granite[3]. Idiomorphic (well developed form and shape) and megacrysts such as K-feldspar, quartz, plagioclase and biotite derived from pegmatite are also observed and collectable.

In situ experiment for the weathering of granitic rocks was performed. The granite pebble was heated by mobile gas burner and quenched in water and repeat the performance to destroy it completely. The heating and cooling show day and night times, respectively. The rocks are destroyed by the difference of temperature and are promoted weathering by the enlargement of grain surface due to the destruction.

For human life the trees in the alluvial fan on the Chinai-river are quite different from those on the Momose-river. The Momose-river favors persimmon but the Chinai-river accepts chestnut even in same temperature. This is because acidic soil derived from granitic rocks is suited for high quality of chestnut. School teachers know Takashima is famous for its high quality of persimmon and chestnut, but did not know that their production district is different. This excursion could make them to know the
difference and the reason. Therefore, they could realize that the geological information was a great help to their habitat and human life.

3.5 Stop E

The color of the estuarine sediments shows light gray due to granitic rocks exposed mainly in the upper reaches. Drifting biotites are on the surface. School teachers detected the same color of sediments between the Stops D and E, and the difference between the Stops C and E. Many teachers did not detect the color difference of the estuaries and lake shore, and a few detected the difference but did not know the reason before attending the excursion. Now they can answer the question why many swimming beaches are scattered on the Lake Biwa? They can answer that swimming beaches need white sand because Japanese feels white sand on the beach beautiful, which were derived by rivers running in granitic rocks. They can also know the link of the tour industry with geological knowledge and field observation.

4 ESTIMATION OF THE EXCURSION WITH PRE- AND POST-QUESTIONNAIRE

In answer to the question “Does the in situ experiments promote your understanding of the field observation?” in the questionnaire, five marked “strongly agree”, one “moderately agree”, and two “agree a little”. They gave comments; “Onsite experiments impress me with the importance of the observation”, “The experiments of weathering of granitic rocks is impressive and would be performed to students” and “Students would easily understand the difference between sand and clay by the experiments.”

![Figure 3. The answers of question “Can you classify grains to pebble, sand, and silt and clay?” at pre- and post-excursions.](image)

The participants classified soil into pebble, sand, silt and clay with the Wentworth grade scale on the stop B. The same questions “Can you classify grains to pebble, sand, and silt and clay?” were asked at pre- and post-excursions. White and black squares show the results of pre- and post-excursions in 2014, respectively in Fig. 3. Seven teachers marked disagree at the pre-excursion, but no teachers marked disagree at the post-excursion. They could conquer the weak point.

ACKNOWLEDGEMENTS

Dr. M. Taga supported and assisted the excursion. Prof. Dr. T. Khan improved English drafts. The study was partly supported by JSPS KAKENHI Grant (No. 15H02915).

REFERENCES
