

Japan

TIMSS Team in Japan
National Institute for Educational Policy Research

Introduction

Overview of Education System

The Fundamental Law of Education, the basis for post-World War II education in Japan, was enacted in 1947 and amended in 2006.¹ This law establishes the basic principles of Japanese education and provides students with equal opportunities to receive a free, compulsory education for nine years. It is the foundation of all education-related laws in Japan, including the School Education Law and the Social Education Law.^{2,3}

The Ministry of Education, Culture, Sports, Science, and Technology (MEXT) is the administrative body responsible for school education. Local bodies establish and maintain virtually all public primary and lower secondary schools and are accountable to a prefectural or municipal board of education.

Both public and private institutions exist at all levels of the academic hierarchy. The government bears most of the expenses for national schools, while municipal and prefectural schools are supported locally, with some assistance from the government. As a rule, private schools are self-supporting through tuition, donations, and contributions from businesses. However, national and prefectural governments do provide financial assistance for maintaining and improving private schools. Throughout Japan, 84.8 percent of kindergarten students, 1.2 percent of primary school students, 7.4 percent of lower secondary school students, and 32.4 percent of upper secondary school students are enrolled in private schools in 2019.⁴

Three types of institutions provide public preprimary education: kindergartens (*Yochien*), daycare centers (*Hoikusho*), and integrated centers for early childhood education and care (*Yohorenkeigata-Nintei-Kodomo-En*). Kindergartens enroll children ages 3 to 6 and are supervised by MEXT. In many cases, kindergarten educational programs last from one to three years. Daycare centers enroll children ages 0 to 6 and are under the jurisdiction of the Ministry of Health, Labour, and Welfare. Integrated centers for early childhood education and care are a new type of preprimary institution designed to promote cooperation between kindergartens and daycare centers. The government authorized these centers in 2006, and MEXT has collaborated with the Ministry of Health, Labour, and Welfare to improve the new system.

Education in Japan follows a 6–3–3 pattern: six years of primary school, three years of lower secondary school, and three years of upper secondary school. Some students attend six-year secondary schools that combine lower secondary education with both general and specialized

upper secondary education. Introduced into the school system in April 1999, these comprehensive secondary schools are designed to focus on the diverse needs of secondary school students. Of students attending these comprehensive schools, 21.1 percent were enrolled in private six-year secondary schools in 2019.⁵

Compulsory education consists of six years of primary education and three years of lower secondary education, and almost all children ages 6 to 15 are enrolled in school. In 2018, 98.8 percent of this age cohort went on to upper secondary school, and 53.3 percent entered a university.⁶ In upper secondary schools, education can be full-time, part-time, or by correspondence. Full-time students complete upper secondary school in three years, and part-time and correspondence students can take longer. In 2018, about 97.3 percent of students in upper secondary schools were enrolled full time.⁷

In public primary and lower secondary schools, there is no official policy on within-school streaming, and students are not tracked. From primary to the end of lower secondary school, a compulsory program of mathematics and science is taught to all students in mixed-ability classes. The same curriculum is prescribed for all students. However, the upper secondary schools try to offer courses geared toward differing abilities and interests. In Grades 11 and 12, schools offer several different curriculum options in mathematics and science.

Upper secondary education is divided into two main streams: general secondary education and specialized secondary education. In 2018, 73.0 percent of students in upper secondary schools were enrolled in the general stream,⁸ which provides general academic preparation. The specialized stream provides vocational and other classes for students who are preparing for a specific career, with subjects such as agriculture, business, fisheries, home economics, nursing, information technology, social work, physical education, music, art, science, mathematics, and English.

Under Japan's curricular reform, the national curricula, called the *Courses of Study*, have been revised seven times since their implementation in 1947, with the goal of keeping up with societal changes over the years and the needs of each age group. Also, in general, there have been changes in the number of class hours. The 6th revised *Course of Study for Elementary Schools and Lower Secondary Schools* was announced in 2008. The 7th revised *Course of Study for Elementary Schools* was announced in March 2017, and it will be fully implemented in April 2020.⁹ However, some parts of the new curricula for mathematics and science are being implemented partially during a transition period from April 2018 to March 2020. Similarly, the revised *Course of Study for Lower Secondary Schools* was announced in March 2017 and will be also fully implemented in April 2021,¹⁰ but some parts of the new curricula for mathematics and science are being implemented partially during a transition period from April 2018 to March 2021. The 6th revised *Course of Study* was implemented for TIMSS 2019 participants; therefore, this chapter refers to the 6th revised *Course of Study*.

Use and Impact of TIMSS

Japan has previously participated in TIMSS 1995, 1999, 2003, 2007, 2011, and 2015. Japan's participation in TIMSS, as well as OECD's PISA, is an activity governed by the education policies of MEXT and is implemented by the National Institute for Educational Policy Research (NIER). Several research studies have used TIMSS results to discuss improvements in teaching and learning.¹¹ Moreover, TIMSS results have been used as reference materials for discussions about education reforms. The fact that TIMSS' National Study Center is located at NIER facilitates further sharing of the results with policymakers. In particular, NIER curriculum specialists in mathematics and science can easily access the results.

The Mathematics Curriculum in Primary and Lower Secondary Grades

The national mathematics standards, objectives, and content for primary, lower secondary, and upper secondary education are presented in the *Courses of Study*.^{12,13,14}

Mathematics is a required subject in primary, lower secondary, and the first year of upper secondary school. Beginning with the 1998 revision of the mathematics curriculum, mathematics activities have been part of the objectives of the curriculum for every grade. In addition, enjoying mathematics is an objective at the primary and lower secondary level, while fostering creativity in mathematics is an objective at the upper secondary level.

The mathematics curriculum consists of three parts: overall objectives for the level (primary, lower secondary, or upper secondary), objectives and content for each grade, and syllabus design. Methods and materials also are specified to some extent in the objectives and contents for each grade, as well as in the construction of teaching plans and remarks about content. In addition, the primary school curriculum prescribes the standard numbers of class periods per year for mathematics. All schools are obliged to address all points relating to mathematics content. Each school must formulate an overall plan for mathematics that includes descriptions of the following: objectives and content; qualities, abilities, and attitudes to be fostered; learning activities; teaching methodology and teaching framework; and a plan for the evaluation of learning.

In the 2008 revision of the curriculum, the mathematics content in Grades 1 to 6 is composed of four areas: Numbers and Calculations, Quantities and Measurements, Geometrical Figures, and Mathematical Relations. At the lower secondary school level, the mathematics content is composed of four areas: Numbers and Algebraic Expressions, Geometrical Figures, Functions, and Making Use of Data.

The overall objectives for mathematics at the primary school level (Grades 1 to 6) are to use mathematical activities to accomplish the following: to help students acquire basic and fundamental knowledge and skills regarding numbers, quantities, and geometrical figures; foster students' ability to think logically and express themselves clearly about everyday matters; help students find pleasure in mathematical activities and appreciate the value of mathematical approaches; and encourage students to use mathematics in both their daily lives and their learning. Exhibit 1 presents the objectives and content for mathematics in the fourth grade.¹⁵

Exhibit 1: Mathematics Objectives and Content, Grade 4 (announced in 2008)

Content Area	Objectives and Content
Numbers and Calculations	Understand decimal numbers and fractions and that integers can be expressed using the decimal system; understand round numbers and appropriate contexts for using them; understand division and extend the ability to divide integers accurately; consolidate the ability to calculate integers and extend the ability to use these calculations; deepen understanding of decimal numbers, including adding, subtracting, multiplying, and dividing decimal numbers and using these calculations; deepen understanding of fractions, including adding and subtracting fractions with the same denominators and using these calculations; and add and subtract using a <i>soroban</i> (Japanese abacus).
Quantities and Measurements	Understand the meaning of units of measurement for area and use calculations to determine areas of geometrical figures; and understand the meaning of units and measurements for angles and measure angles.
Geometric Figures	Understand plane figures (e.g., parallelograms, rhombuses) and solid figures (e.g., rectangular parallelepiped) by observing their elements and exploring the relationships among those elements; recognize the elements and positional relationships of two-dimensional and three-dimensional geometrical figures through activities such as observing and drawing these figures.
Mathematical Relations	Represent and explore the relationships between two numbers or quantities as they vary simultaneously; understand the algebraic expressions that represent the relationships between numbers or quantities and use these expressions; deepen understanding of the properties of the four basic operations; and gather and organize data according to purpose, represent data clearly by using tables and graphs, and explore the features of data.

The overall objectives for mathematics at the lower secondary level (Grades 7 to 9) are to use mathematical activities to do the following: help students deepen their understanding of fundamental concepts, principles, and rules regarding numbers, quantities, and geometrical figures; help students acquire skills in mathematical processing and representation so that they can develop their ability to analyze and represent phenomena mathematically; help students enjoy mathematical activities and appreciate the value of mathematics; and encourage students to apply their mathematical understanding and ability when they think and evaluate.¹⁶ Exhibit 2 presents the objectives and content for mathematics in the eighth grade.¹⁷

Exhibit 2: Mathematics Objectives and Content, Grade 8 (announced in 2008)

Content Area	Objectives and Content
Numbers and Algebraic Expressions	Develop the ability to discern algebraic relationships in concrete phenomena, represent these relationships in algebraic expressions using letters, and interpret these expressions; understand how to calculate the four fundamental operations with expressions using letters; and solve and interpret simultaneous linear equations in two variables.
Geometric Figures	Through activities such as observing, manipulating, and experimenting, discover the properties of basic plane figures and verify those properties based on the properties of parallel lines; understand the congruence of geometrical figures and verify the properties of geometrical figures based on the conditions for congruence of triangles; and develop the ability to think and represent logically.
Functions	By exploring concrete phenomena, understand linear functions and develop the ability to discover, represent, and analyze functional relationships.
Making Use of Data	Develop the ability to understand and use probability through exploring uncertain phenomena and be able to use it to analyze and represent data.

The Science Curriculum in Primary and Lower Secondary Grades

The national science standards, objectives, and content for primary, lower secondary, and upper secondary education are presented in the *Courses of Study*.^{18,19,20}

Science instruction begins in the third grade and is a required subject throughout compulsory education. The science curriculum consists of three parts: overall objectives for the level (primary, lower secondary, or upper secondary); objectives and contents for each grade or section; and syllabus design. All schools are obliged to address all points relating to the content of science. Each school must formulate an overall plan for science that includes descriptions of the following: objectives and content; qualities, abilities, and attitudes to be fostered; learning activities; teaching methodology and teaching framework; and a plan for the evaluation of learning.

The overall objectives for science in Grades 3 to 6 are as follows: enable students to become familiar with nature and to carry out observations and experiments from their own perspective; help students develop their problem-solving abilities; nurture students' affection for the natural world; help students develop a realistic understanding of natural phenomena; and encourage students to embrace scientific perspectives and ideas.²¹

The objectives for science in fourth grade are to help students do the following:

- Develop perspectives and ideas about the properties and functions of objects by investigating air, water, changes in states of matter, and electrical phenomena in relation to the functions of power, heat, and electricity and by exploring the identified problems and making learning materials with interest
- Develop a loving and protective attitude toward living things
- Develop perspectives and ideas about the structure of the human body, the activities of animals, the growth of plants, meteorology, and the movement of the moon and stars by investigating them in relation to movement, seasons, temperature, and time and by exploring the identified problems with interest²²

The science curriculum in the fourth grade is divided into two areas: Matter and Energy, and Life and the Earth. Exhibit 3 presents the content covered in each area.²³

Exhibit 3: Science Content, Grade 4 (announced in 2008)

Content Area	Topic	Content
Matter and Energy	Properties of air and water	Help students develop their ideas about the properties of air and water by exploring changes in volume and pressure when air and water are compressed in a closed space.
	Metal, water, air, and temperature	Help students develop their ideas about the properties of metals, water, and air by exploring the changes that occur when metals, water, and air are heated and cooled.
	Function of electricity	Help students develop their ideas about electricity by exploring the functions of a dry battery and photocell when they are attached to small bulbs and motors.
Life and the Earth	Structure and movement of the human body	Help students develop their ideas about the relationship between the structure and movement of the human body by exploring the movement of bones and muscles, by observing the movement of humans and other animals, and by using teaching materials.
	Seasons and living things	Help students develop their ideas about the relationship between seasons and animal activities and plant growth by finding and raising familiar animals and plants and by exploring the activities of animals and the growth of plants in different seasons.
	Weather conditions	Help students develop their ideas about weather conditions and the change of water in the natural world by observing temperature changes over the course of a day, the process of water changing to vapor, and by exploring changes in weather and temperature and the relationship between water and vapor.
	The moon and stars	Help students develop their ideas about the characteristics and movement of the moon and stars by observing them and by exploring the position of the moon and the color, brightness, and position of stars.

The overall objectives for science at the lower secondary level (Grades 7 to 9) are as follows: enable students to take an active interest in natural things and phenomena and to carry out observations and experiments with a sense of purpose; help students to develop the ability to perform investigations scientifically and to develop a positive attitude about these investigations; help students to deepen their understanding of natural things and phenomena; and help students to develop scientific ways of looking and thinking.²⁴

The science curriculum at the lower secondary level is divided into two fields: Physical Science, and Biology and Earth Science. The objectives for physical science at Grade 8 are to enable students to do the following:²⁵

- Take an active interest in things and phenomena related to matter and energy; acquire methods for discovering patterns; and acquire methods for resolving problems through activities that explore these things and phenomena.
- Acquire skills for observation and experimentation by making observations and conducting experiments on physical events and phenomena and develop the ability to analyze, interpret, and express the results; understand familiar physical phenomena, electric currents and their use, and motion and energy; and develop scientific ways of looking at and thinking about these events and phenomena.
- Acquire skills for observation and experimentation by making observations and conducting experiments on chemical substances and associated phenomena and develop the ability to analyze, interpret, and express the results; understand the role of chemical substances in daily life; understand chemical changes and atoms (molecules), and chemical changes and particles; and develop scientific ways of looking at and thinking about these things and phenomena.
- Increase awareness about the connections between scientific and technological developments and human life through activities that explore matter and energy; and through these activities, develop an attitude of scientific ways of thinking and a comprehensive view of nature.

The objectives for biology and earth science at Grade 8 are to enable students to do the following:

- Take an active interest in living things (including the natural things and phenomena surrounding them); acquire methods for discovering diversity and patterns; and acquire methods for resolving problems through activities that explore these natural things and phenomena.
- Acquire skills for observation and experimentation by making observations and conducting experiments on living things and phenomena and develop the ability to analyze, interpret, and express the results; understand the lives and varieties of living things; and develop scientific ways of looking at and thinking about these living things and the continuity of life and phenomena.
- Acquire skills for observation and experimentation by making observations and conducting experiments on geological events and phenomena and develop the ability to analyze, interpret, and express the results; understand the composition and changes of the Earth, the climate and its changes, and the Earth and the universe; and develop scientific ways of looking at and thinking about these events and phenomena.

- Develop respect for life and an attitude of contributing to the conservation of the environment through activities that explore living things and phenomena in nature surrounding them; and through these activities, develop a comprehensive view of nature.

Exhibit 4 presents the content covered in the two science fields—Physical Science, and Biology and Earth Science—during eighth grade.²⁶

Exhibit 4: Science Content, Grade 8 (announced in 2008)

Content Area	Topic	Content
Physical Science	Electric currents and their uses	Understand the function of electric currents and the relationship between electric currents and voltage by observing and conducting experiments; and develop elementary ways of looking at and thinking about electric currents and magnetic fields in connection with everyday life and society.
	Chemical changes, atoms, and molecules	Understand the changes in substances and their quantitative relationships with regard to chemical combinations and decomposition by observing and conducting experiments; and develop ways of looking and thinking that attempt to connect these changes to atomic and molecular models.
Biology and Earth Science	The lives of animals and the transitions of living things	Through observation, understand that the bodies of living things are made up of cells; understand the body structure and functions of animals by observing and conducting experiments; deepen recognition of the diversity of animal life; and understand the transitions in living things that occur over time.
	Weather and its changes	Discover the relationship between meteorological elements and weather changes by observing local weather; and deepen recognition of the mechanisms and patterns of climatic phenomena.

Professional Development Requirements and Programs

In 2003, Japan instituted a new professional development system under which all teachers with 10 years of experience receive training, according to their individual abilities and aptitudes, in topics such as course instruction and student guidance. Local boards of education offer courses and workshops to improve teachers' instructional abilities and develop educational knowledge that is useful for instruction. Lesson study (*Jyugyou kenkyu*), which usually involves studying teaching materials and the course of study, a process called *Kyouzai Kenkyuu*, discussing lesson plans with other teachers before a lesson, and a post-lesson discussion focusing on how students responded to the lesson and how the course of study should be implemented, is a common type of training to improve teaching skills.^{27,28}

Monitoring Student Progress in Mathematics and Science

Since the 1980s, three types of large-scale assessments have been held in Japan: the Assessment of Implementation of Curriculum, the Assessment of Specific Issues of Education, and the National Assessment of Academic Ability.²⁹ The National Assessment of Academic Ability has been held every year since 2007. Each assessment has different aims, as shown in Exhibit 5.

Exhibit 5: Assessment of Education for Primary and Secondary School Students Since the 1980s

Title	Aim	Grade, Survey Method	Subjects	Date
The Assessment of Implementation of Curriculum	Collect data for revising the curriculum and improving methods of instruction	Grades 5, 6, 7, 8, and 9 Sample of Students	Japanese/ Social Studies/ Mathematics/ Science *English: Only for lower secondary school	Before revising the curriculum and after the revised curriculum is implemented.
The Assessment of Specific Issues of Education	Collect data about specific issues in education	Depends on the subject Sample of Students	Japanese/ Mathematics (2005) Science(2006) English (2005, 2010) Social Studies/ Technology and Home Economics (2007) Music (2008–2009) Art (2009–2010) Logical Thinking (2012)	Annually 2005–2012
The National Assessment of Academic Ability	Review achievement and issues in education	Grades 6 and 9 Complete Population (2007–2009, 2013–) Sample of Students (2010 and 2012)	Japanese/ Mathematics Science was added in 2012 and English was added in 2019. Both Science and English are conducted every three years.	Every April since 2007 (except 2011 because of the earthquake)

In primary and lower secondary schools, student progress is reported to parents at the end of each school term in a report card that provides both norm-referenced and criterion-referenced evaluations. In mathematics and science, teachers use the following four aspects of criterion-referenced evaluation: interest, eagerness, and attitude toward mathematics or natural phenomena; mathematical or scientific thinking; expression and processing; and knowledge and understanding.

Students in Japan also take entrance examinations for both upper secondary schools and universities. Almost all prefectural boards of education administer the entrance examination for

prefectural and municipal upper secondary schools, which students enter in the 10th grade. These entrance examinations cover several subjects, including mathematics and science.

To enter national, prefectural, municipal, and most private universities, applicants must take an entrance examination called the National Center Test for University Admissions. This test covers several subjects, including mathematics and science, and is administered by the National Center for University Entrance Examination, an incorporated administrative agency. Applicants must also pass specific entrance examinations administered by individual universities.

Special Initiatives in Mathematics and Science Education

Since 2002, MEXT has been designating Super Science High Schools (SSHs), which implement advanced science and mathematics education. By supporting those schools through the Japan Science and Technology Agency (JST), MEXT cultivates students' science ability and thinking, and expands the development of international science and technology human resources for the future. In 2019, 212 out of 4,887 high schools in Japan promote distinctive initiatives for SSH.³⁰

References

- ¹ *Kyouiku Kihon Hou* [Fundamental Law of Education]. (2006).
- ² *Shakai Kyouiku Hou* [School Education Law]. (2010).
- ³ *Gakkou Kyouiku Hou* [Social Education Law]. (2009).
- ⁴ Ministry of Education, Culture, Sports, Science, and Technology. (2019). *Gakkou kihon chousa* [Basic survey on schools]. Tokyo: Author.
- ⁵ Ministry of Education, Culture, Sports, Science, and Technology. (2019). *Gakkou kihon chousa* [Basic survey on schools]. Tokyo: Author.
- ⁶ Ministry of Education, Culture, Sports, Science, and Technology. (2018). *White paper on education, culture, sports, science, and technology*. Tokyo: Author.
- ⁷ Statistics Bureau and Statistical Research and Training Institute. (2020). *Nippon toukei nenkan 2020* [Japan statistical yearbook 2020]. Tokyo: Author. Retrieved from <http://www.stat.go.jp/english/data/nenkan/index.htm>
- ⁸ Statistics Bureau and Statistical Research and Training Institute. (2020). *Nippon toukei nenkan 2020* [Japan statistical yearbook 2020]. Tokyo: Author. Retrieved from <http://www.stat.go.jp/english/data/nenkan/index.htm>
- ⁹ Ministry of Education, Culture, Sports, Science, and Technology. (2018). *Shougakkou gakusyuu shidou youryou* [Course of Study for elementary schools]. Tokyo: Author.
- ¹⁰ Ministry of Education, Culture, Sports, Science, and Technology. (2018). *Chuugakkou gakusyuu shidou youryou* [Course of Study for lower secondary schools]. Tokyo: Author.
- ¹¹ Saruta, Y. (2010). *Ronri-teki-shikou ni motozuita kagaku-teki-hyougen-ryoku ni kansuru kenkyu* [Study of scientific expression based on logical thinking]. (Doctoral dissertation). Hiroshima University, Hiroshima, Japan.
- ¹² Ministry of Education, Culture, Sports, Science, and Technology. (2008). *Shougakkou gakusyuu shidou youryou* [Course of Study for elementary schools]. Tokyo: Author.

- ¹³ Ministry of Education, Culture, Sports, Science, and Technology. (2008). *Chuugakkou gakusyuu shidou youryou* [Course of Study for lower secondary schools]. Tokyo: Author.
- ¹⁴ Ministry of Education, Culture, Sports, Science, and Technology. (2009). *Koutougakkou gakusyuu shidou youryou* [Course of Study for upper secondary schools]. Tokyo: Author.
- ¹⁵ Ministry of Education, Culture, Sports, Science, and Technology. (2008). *Guidelines for teaching elementary school* (English version). Tokyo: Author. Retrieved from http://www.mext.go.jp/a_menu/shotou/new-cs/youryou/eiyaku/1261037.htm
- ¹⁶ Ministry of Education, Culture, Sports, Science, and Technology. (2008). *Guidelines for teaching junior high school* (English version). Tokyo: Author. Retrieved from http://www.mext.go.jp/a_menu/shotou/new-cs/youryou/eiyaku/1298356.htm
- ¹⁷ Ministry of Education, Culture, Sports, Science, and Technology. (2008). *Guidelines for teaching junior high school* (English version). Tokyo: Author. Retrieved from http://www.mext.go.jp/a_menu/shotou/new-cs/youryou/eiyaku/1298356.htm
- ¹⁸ Ministry of Education, Culture, Sports, Science, and Technology. (2008). *Shougakkou gakusyuu shidou youryou* [Course of Study for elementary schools]. Tokyo: Author.
- ¹⁹ Ministry of Education, Culture, Sports, Science, and Technology. (2008). *Chuugakkou gakusyuu shidou youryou* [Course of Study for lower secondary schools]. Tokyo: Author.
- ²⁰ Ministry of Education, Culture, Sports, Science, and Technology. (2009). *Koutougakkou gakusyuu shidou youryou* [Course of Study for upper secondary schools]. Tokyo: Author.
- ²¹ Ministry of Education, Culture, Sports, Science, and Technology. (2008). *Guidelines for teaching elementary school* (English version). Tokyo: Author. Retrieved from http://www.mext.go.jp/a_menu/shotou/new-cs/youryou/eiyaku/1261037.htm
- ²² Ministry of Education, Culture, Sports, Science, and Technology. (2008). *Guidelines for teaching elementary school* (English version). Tokyo: Author. Retrieved from http://www.mext.go.jp/a_menu/shotou/new-cs/youryou/eiyaku/1261037.htm
- ²³ Ministry of Education, Culture, Sports, Science, and Technology. (2008). *Guidelines for teaching elementary school* (English version). Tokyo: Author. Retrieved from http://www.mext.go.jp/a_menu/shotou/new-cs/youryou/eiyaku/1261037.htm
- ²⁴ Ministry of Education, Culture, Sports, Science, and Technology. (2008). *Guidelines for teaching junior high school* (English version). Tokyo: Author. Retrieved from http://www.mext.go.jp/a_menu/shotou/new-cs/youryou/eiyaku/1298356.htm
- ²⁵ Ministry of Education, Culture, Sports, Science, and Technology. (2008). *Guidelines for teaching junior high school* (English version). Tokyo: Author. Retrieved from http://www.mext.go.jp/a_menu/shotou/new-cs/youryou/eiyaku/1298356.htm
- ²⁶ Ministry of Education, Culture, Sports, Science, and Technology. (2008). *Guidelines for teaching junior high school* (English version). Tokyo: Author. Retrieved from http://www.mext.go.jp/a_menu/shotou/new-cs/youryou/eiyaku/1298356.htm
- ²⁷ Takahashi, A. & McDougal, T. (2016) *Collaborative lesson research: maximizing the impact of lesson study*. Berlin: Springer Verlag. doi: 10.1007/s11858-015-0752-x
- ²⁸ Lewis, C. C., & Hurd, J. (2011). *Lesson study step by step: How teacher learning communities improve instruction*. Portsmouth, NH: Heinemann.

-
- ²⁹ Japan Society of Mathematical Education. (2010). *Journal of Japan Society of Mathematical Education*, 92(11). Tokyo: Author.
- ³⁰ Ministry of Education, Culture, Sports, Science, and Technology. (2018). *White paper on education, culture, sports, science, and technology*. Tokyo: Author.