Exhibit 19: National Policies Regarding Use of Information and Communications Technology (ICT) and Digital Devices in Mathematics and Science Instruction at the Eighth Grade

Reported by National Research Coordinators

Country	Description of the National Policies for Use of Information and Communications Technology (ICT) and Digital Devices	
	Mathematics Instruction	Science Instruction
Australia	The use of digital devices is encouraged but not mandated. The F–10 Australian Curriculum includes general capabilities, including ICT capability, that are expected to be addressed through the learning areas, including mathematics. The mathematics curriculum content descriptions refer to "using appropriate digital technologies."	Same as for mathematics
Bahrain	The Ministry of Education implements 2 major projects related to e-learning: the King Hamad Project for Future Schools and the Digital Empowerment in Education project. Both projects entail the use of digital devices and include e-lessons and digital enrichments that students can access in class and at home through the Ministry's portal. Classes are also equipped with smart/interactive boards.	Same as for mathematics
Chile	According to the national curriculum, ICT should be used to support the understanding of mathematical concepts, to model and represent functions and geometrical objects, and to organize and communicate results. In calculations, ICT should only be used to check work, implement a large number of single operations, or implement operations with very large numbers.	According to the national curriculum, ICT should be used to collect, process, and communicate information in science. ICT is an essential part of scientific literacy and should be used for measurement, registering and modeling data, and communicating results.
Chinese Taipei	Once students have learned basic computational skills, teachers can introduce technology aids for solving mathematics problems. Calculators should not interfere with teaching concepts and are typically only used in junior and senior high school.	Teachers should teach with various media and resources, including computers and the internet, to engage students in searching for information.
Cyprus	No policy	Physics teachers can use digital devices to support implementation of the curriculum, such as the use of data loggers, computers, and sensors. Teachers may also use smartphones for formative evaluation and for video analysis.
Egypt	Students can use calculators from Grade 5.	For teaching and learning science, students and teachers may use digital devices such as computers in schools' multimedia centers. In the last 3 years, the Ministry of Education has produced computer labs and some digital curricula.
England	According to the national curriculum, ICT, including calculators, should not be used as a substitute for good written and mental arithmetic. In secondary schools, teachers should use their judgment about when ICT tools should be used.	Same as for mathematics
Finland	Programming is integrated into mathematics instruction. An objective of instruction is to inspire students to design algorithms in the form of computer programs in graphic programming environments. ICT and calculators are used in teaching and learning. Education providers and teachers can decide what kinds of digital devices to use.	ICT is integrated into science instruction in a variety of ways. The use of technology promotes equality and equity among students in their learning. For example, an objective of instruction in physics is to guide students to use ICT for acquiring, processing, and presenting information and measurement results, and to support the students' learning by using illustrative simulations.
France	Students use digital tools such as spreadsheets, calculators, dynamic geometry, and programming software to manage real or experimental data, make representations and simulations, and to program technical objects.	According to the science curriculum, students are taught to search for information on the internet to answer scientific questions or problems (i.e., choose relevant keywords and assess the reliability of sources and the validity of results); use data acquisition and processing tools, database software, simulations, and digital models; and use digital tools to share information on a scientific subject and produce scientific documents.
Georgia	No policy	No policy
Hong Kong SAR	The use of graphing calculators and the availability of computers and other information technology aids in the classrooms impacts content and strategies for teaching and learning mathematics. ICT may be used in a variety of ways in mathematics classes, including for data analysis, simulations, graphical presentations, symbolic manipulation, and observing patterns. The appropriate use of ICT in the teaching and learning of mathematics is emphasized in the mathematics curriculum.	ICT is 1 of the 4 key tasks to promote learning to learn. These tasks can be adopted and adapted in the Science Education Key Learning Areas (KLAs) to enliven instruction, and to help learners progress toward the vision of whole-person development.
Hungary	Calculators and computers are used alongside books, such as encyclopedias, informative books, and exercise books, on mathematics development tasks.	Students engage in computer-supported learning, such as searching for information, using the library, internet, databases, and simulations and applications for measuring.
Iran, Islamic Rep. of	Students may use calculators in class, with the exception of when they are learning to compute. Calculator-based activities are also provided in mathematics textbooks. The use of calculators and computers is permitted but not mandated; usage is based on teachers' decisions.	No explicit policy, but there are activities in the science curriculum that require calculators or computers.

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Reported by National Research Coordinators

(Continued)

Country	Description of the National Policies for Use of Information and Communications Technology (ICT) and Digital Devices	
	Mathematics Instruction	**Science Instruction**
Ireland	The Junior Certificate Mathematics Curriculum highlights the importance of using technology to support mathematics applications, such as enabling children to think and communicate quantitatively and spatially, solve problems, and recognize situations in which mathematics can be applied. Students should be able to generate data or acquire data from other sources, including the internet. Students should also summarize data (e.g., in spreadsheets) and engage with dynamic geometry software. The mathematics curriculum provides for the introduction and use of calculators from Grade 4 onward; by Grade 8, students are expected to be able to use calculators to help develop their problem-solving skills by enabling them to focus on the structure of a problem and explore different solutions.	Students should have opportunities to develop a range of key skills and use digital media and technology to communicate; stimulate creativity; develop numeracy skills; and understand, access, manage, and share content. Students should also be taught how to be safe, responsible, and ethical when using digital technology.
Israel	There are only general statements advocating the use of computers in the different processes of learning, both in algebra and geometry. Calculators are allowed in instruction and testing.	There are only general statements about integrating computers into science learning activities. The science curriculum includes references to computerized activities for each grade.
Italy	The objectives for digital education are primarily established in the National Plan for Digital Education (*Piano Nazionale Scuola Digitale*; PNSD). It is organized into 35 broad actions, covering all of the areas connected to the development of ICT in public education. ICT and its use in education is viewed as a transversal objective, necessary to fulfill the requirements on each subject.	Same as for mathematics
Japan	In teaching each subject, consideration should be given to proper use of tools such as a *soroban* (Japanese abacus), calculators, computers, and ICT to improve learning results. In particular, technology should be considered for teaching content related to numerical calculations, as well as for activities such as observation, manipulation, and experimentation.	For the instruction in each field, consideration should be given to ensure the proactive and appropriate use of tools, such as computers and ICT, when searching for information in the course of observations and experiments, conducting experiments, data processing, and experimental measurements.
Jordan	The Education Strategy Plan emphasizes the use of ICT in teaching and learning mathematics.	The Education Strategy Plan emphasizes the use of ICT in the teaching and learning process. Digital content for the science curriculum is available for students and teachers to use.
Kazakhstan	No policy	No policy
Korea, Rep. of	Teachers should use a diverse and appropriate set of educational equipment and materials to promote the effective learning of mathematics. They should also make use of a variety of tools such as calculators, computers, and software to help students perform complex computations (when not learning computation); help them develop a deeper understanding of mathematical concepts, principles, and laws; and enhance their problem-solving skills.	Students should have the ability to understand and express scientific and technical information through a variety of media, such as computers and audiovisual equipment. Teachers should use the latest ICT and devices, such as models, audiovisual materials, software, computers, smart devices, and the internet. Science teachers should also teach mathematical thinking and computer use functions related to learning science topics.
Kuwait	No explicit policy, but schools typically allow students to use calculators for simple mathematics problems and validation of an answer or a scientific rule during class. Calculators are not allowed during examinations.	Same as for mathematics
Lebanon	No policy	No policy
Lithuania	The curriculum contains guidelines for incorporating ICT into instruction. Computer programs can be used during lessons to introduce new material. In Grades 7–8, integrated lessons include ICT together with various other subjects.	Same as for mathematics
Malaysia	ICT should be used for exploratory activities involving various methods such as the use of concrete materials (e.g., origami) or dynamic geometric software.	Teachers are encouraged to use digital devices in the classroom, such as searching for information, and preparing and making presentations. E-learning is also implemented such that students and teachers can use social media platforms to communicate about lessons. The use of digital devices is recommended in data handling, especially in project-based learning.
Morocco	The Ministry of Education provides digital resources for schools. Most schools received CDs and DVDs that contain the target lessons and subjects in digital formats to be used in the multimedia room. The Ministry of Education website also includes digital lessons, most of which were contributed by classroom teachers.	Same as for mathematics
New Zealand	No policy. The use of technology is discussed in general terms, but not specifically within mathematics.	No policy. The use of technology is discussed in general terms, but not specifically within science.

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(Continued)

Country	Description of the National Policies for Use of Information and Communications Technology (ICT) and Digital Devices	
	Mathematics Instruction	Science Instruction
Norway	Digital tools are used in mathematics for games, exploration, visualization, and presentation. The curriculum for digital skills involves being aware of, using, and evaluating the role of digital tools for estimation, problem-solving, simulation, and modeling. It is also important that students learn to find information, analyze, process, and present data with appropriate tools, and be critical of sources, analyses, and results.	Digital tools are used in science for exploration, measurement, visualization, simulation, registration, documentation, and publication when performing experiments and fieldwork. Digital animations, simulations, and games are good aids for stimulating creativity, and demonstrating and visualizing natural science problems and research questions. Critical assessment of internet-based information reinforces the work in this subject. Digital communication systems make it possible to discuss natural science problems and research questions.
Oman	No policy	No policy
Portugal	The use of digital technology, such as Scratch, Excel, and numerical applications, is encouraged for teaching problem solving and other learning tasks. The use of calculators is recommended only for specific situations, such as computing with large numbers, square roots, and completing multistep calculations.	No policy
Qatar	The mathematics curriculum includes suggestions for teachers on the use of ICT tools and digital devices. Students should use the square root and cubic root keys on scientific calculators, interpret scientific notation generated and displayed on scientific calculators, and use graphing calculators, graphing software, and spreadsheets to explore line graphs. Students are also expected to explore relationships using geometry software.	Students should use the internet to research different topics, use data loggers to measure the temperature, and make presentations to show their results.
Romania	No policy	No policy
Russian Federation	According to the Federal State Educational Standard of Basic General Education, students learning mathematics and computer science must develop basic skills and abilities to use computers, be able to formalize and structure information, draw typical flat shapes and 3-dimensional bodies using simple computer tools, and choose how to represent data in accordance with the task (through tables, diagrams, graphs, charts) using appropriate software for data processing. Students are also expected to exercise safe and appropriate behavior when working with computer programs and on the internet, as well as comply with information ethics and laws.	In accordance with the basic educational curriculum, students use ICT to search and apply the information resources necessary to solve educational and practical problems, and use computer technology (including the choice of adequate task tool hardware, software and services) to solve ICT learning tasks, such as calculation, writing letters, essays, reports, and abstracts; and creating presentations. Students will also create information resources of different types and for different audiences, and observe information ethics and information security rules.
Saudi Arabia	No policy	No policy
Singapore	Schools are guided by the Ministry of Education's Masterplan for ICT in Education in their use of digital devices to support teaching and learning in all subjects. The most recent plan aims to broaden the use of ICT for quality learning to support the curriculum. For mathematics, the curriculum framework states that for students to develop a deep understanding of mathematical concepts and make sense of their applications, they should be exposed to technological aids that help them relate abstract mathematical concepts to concrete experiences. In today's classrooms, mathematical skills also include the abilities to use spreadsheets and other software to learn and do mathematics. The role of ICT in the teaching and learning of mathematics is further articulated under the Principles of Teaching in the mathematics syllabus: Teaching should connect learning to the real world, harness ICT tools, and emphasize twenty-first century competencies. Teachers should consider the affordances of ICT to help students learn. ICT tools can help students understand mathematical concepts through visualizations, simulations, and representations, as well as work collaboratively and think critically about solutions. They can also support exploration and experimentation, and extend the range of problems accessible to students.	Schools are guided by the Ministry of Education's Masterplan for ICT in Education in their use of digital devices to support teaching and learning in all subjects. The most recent plan aims to broaden the use of ICT for quality learning to support the curriculum. For science, it translates into staying up to date with the changing education landscape and developments in education technology, and helping students develop twenty-first century competencies, a broad and deep foundation of learning in science, and lifelong learning skills. ICT supports the inquiry process and also facilitates student collaboration and self-directed learning; online collaborative tools enable students to discuss their ideas or findings and consult field experts. Internet-enabled devices can be used to facilitate data collection and analysis in situated learning. Students can also explore and visualize abstract concepts using simulation tools.
South Africa	Teachers provide direction to students regarding when they are permitted to use calculators. Calculators should be used for computations involving large numbers and when students' knowledge of number facts or concepts are not being explicitly assessed. Students should not become dependent on calculators; calculators remain a useful tool for checking solutions.	No policy

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Reported by National Research Coordinators

(Continued)

Country	Description of the National Policies for Use of Information and Communications Technology (ICT) and Digital Devices	
	Mathematics Instruction	**Science Instruction**
Sweden	The national curriculum states that schools are responsible for ensuring that each student can use modern technology as a tool in the search for knowledge, communication, creativity, and learning. In mathematics, students should be given opportunities to develop knowledge in using digital tools and programming to explore problems and mathematical concepts, make calculations, and present and interpret data. Students may use mental arithmetic, written methods, or digital tools to approximate natural numbers and simple numbers in decimal form. Students are also taught how to program in different programming environments using algorithms, specifically focusing on how algorithms can be created, tested, and improved when programming for mathematical problem solving. Depiction and construction of geometrical objects should be taught both with and without digital tools, as should designing and interpreting tables, diagrams, and graphs. Students are also expected to produce scales for reducing and increasing 2- and 3-dimensional objects, assess risk and chance based on computer simulations and statistical material, and understand how functions can be used, both with and without digital tools, to examine change, rate of change, and relationships.	In science, students should be given opportunities to develop different skills within different topics with the use of both digital tools and other equipment, and to look for answers by using different types of sources.
Turkey	According to the curriculum, students should learn digital competence—the safe and critical use of ICT for business, daily life, and communication. Interactive activities with appropriate ICT may be used in instruction.	Same as for mathematics
United Arab Emirates	Students may use graphing calculators, simple calculators, and tablets.	No policy
United States	Most states do not have policies regarding computer use. However, many states have standards for technology literacy requiring computer use in mathematics instruction. Some Common Core State Standards in mathematics require the use of technology in the middle to upper grades. Many school districts and schools have chosen to integrate technology, such as computers, tablets, and interactive whiteboards, with their mathematics instruction. States are increasingly providing or enabling digital devices and digital content for students and faculty to use in school and at home. Some states also have standards for use of calculators in instruction as well as the progression from 4-function to graphing calculators. Individual districts may give guidelines regarding calculator usage during instructional time. Calculator usage is common in Grade 8 mathematics courses; data from the 2017 National Assessment of Educational Progress (NAEP) showed that for the majority of Grade 8 students, teachers reported unrestricted use of calculators during their mathematics lessons.	Most states do not have policies regarding computer and calculator use in science instruction. However, many states and national science standards documents include statements related to the use of technology such as computers, calculators, and other digital tools. The Next Generation Science Standards (NGSS) emphasize science practices that benefit from the use of technology, such as analyzing and interpreting data, using mathematical and computational thinking, as well as developing and using models to describe or predict science phenomena. The Every Student Succeeds Act (ESSA; 2015) emphasizes the importance of using technology in the classroom as a part of student enrichment, and many schools have chosen to integrate technology with their science instruction. States are increasingly providing or enabling digital devices and digital content for students and faculty to use in school and at home.
Benchmarking Participants		
Ontario, Canada	According to the Ontario Curriculum Guide, calculators and computers can be used to perform operations, make graphs, and organize and display data. Students may use digital devices to investigate number and graphing patterns, geometric relationships, and different representations to simulate situations and to extend problem solving. It is important that students learn when it is appropriate to apply mental computation, reasoning, and estimation skills to predict and check answers. Teachers can use ICT both for whole class instruction and to design programs that meet diverse student needs. ICT can be used to reduce the time spent on routine mathematical tasks; promote thinking and concept development; introduce simulations, multimedia resources, databases, and computer-assisted learning modules; and connect students to other schools, at home and abroad.	According to the Ontario Curriculum Guide, ICT provides a range of tools that can significantly extend and enrich teachers' instructional strategies and support students learning in science and technology. Computer programs can be used to help students collect, organize, and sort the data and to write, edit, and present reports on their findings. ICT also can be used to simulate investigations when field studies on a particular topic are not feasible and to connect students to other schools, at home and abroad.
Quebec, Canada	No policy	The Science and Technology Program proposes the use of a number of information and communication technologies in the teaching of this discipline.

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Reported by National Research Coordinators

(Continued)

Country	Description of the National Policies for Use of Information and Communications Technology (ICT) and Digital Devices	
	Mathematics Instruction	**Science Instruction**
Moscow City, Russian Fed.	According to the Federal State Educational Standard of Basic General Education, students learning mathematics and informatics will develop basic skills and abilities to use computers, be able to formalize and structure information, draw typical flat shapes and 3-dimensional bodies using simple computer tools, and choose how to represent data in accordance with the task (through tables, diagrams, graphs, charts) using appropriate software for data processing. Students are also expected to exercise safe and appropriate behavior when working with computer programs and on the internet, as well as comply with information ethics and laws.	In accordance with the General Educational Program, students will utilize ICT to search and apply the information resources necessary to solve educational and practical problems and use computer technology (including the choice of adequate task tool hardware and software and services) to solve information and communication learning tasks, such as calculation; writing letters, essays, reports, and abstracts; and creating presentations. Students will also create information resources of different types and for different audiences, and observe information ethics and information security rules.
Gauteng, South Africa	Same as South Africa	
Western Cape, South Africa	Same as South Africa	
Abu Dhabi, UAE	Same as United Arab Emirates	
Dubai, UAE	Same as United Arab Emirates	