Chapter 7
Report on ICT in Education in the Republic of Estonia

Hans Põldoja

7.1 Overview of the Country

7.1.1 The Geography and History

Estonia is a small country located in Northern Europe, on the eastern coast of the Baltic Sea. It borders with Latvia in the south and Russia in the east. With the area of 45,000 km^2, it is slightly larger than the Netherlands. However, the population of Estonia is only 1.3 million people. The capital and the largest city of Estonia is Tallinn (population 439,000), which is situated on the northern coast. The second largest city Tartu (population 99,000) is a university town situated 186 km southeast of Tallinn. 69% of the population lives in urban areas and much of the economic activity is concentrated around Tallinn and Tartu. The sparsely populated areas in the countryside are a challenge both for the regional economic development and for the educational system.

Estonia has had a turbulent history with a number of rulers. Since the medieval times it has been under Danish and Swedish rule, until it was conquered by the Russian Empire in 1710. Despite the various rulers, Estonia has managed to maintain and develop its language and culture. The first university was established under the Swedish rule in Tartu on 1632. In the nineteenth century, Estonia had an enlightenment and a national awakening period which leads to declaring the national independence in 1918. The first period of independence lasted until 1940. After the World War II, the Estonia remained occupied by the Soviet Union until 1991. After restoring the independence, the country has had a quick economical development and has joined both the European Union and NATO in 2004.

H. Põldoja (✉)
School of Digital Technologies, Tallinn University, Tallinn, Estonia
e-mail: hans.poldoja@tlu.ee

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7.1.2 Cultural Development

The official language is Estonian and 68.7% of the population are Estonians. Other ethnic groups include Russians (24.9%), Ukrainians (1.8%), Belarusians (0.9%) and Finns (0.6%). Over the last two decades, Estonia has had initiatives that support foreigners to learn Estonian. In areas with significant Russian-speaking minority, there are also Russian schools. Basic education can be obtained in Russian, but in upper secondary level at least 60% of courses are taught in Estonian. Higher education in public universities is provided in Estonian, but there is an increasing number of study programmes in English which also attract international students.

7.1.3 The Political System

The Estonian political system is based on parliamentary democracy in which the single-chamber parliament with 101 members influences the governing of the state by determining state budget, approving the legislation and appointing high officials, including the prime minister and the president. The government carries out Estonian domestic and foreign policy which is shaped by the parliament. The president is the highest representative of the state with a limited role in the legislation. The main goals of Estonian foreign policy is to maintain national security and stable international relationships through involvement in the European Union and NATO.

7.1.4 Economic Development

Since restoring the independence in 1991, Estonia has reformed its economic system into a modern service economy. In 2011, Estonia became the member of the euro-zone and its economy is strongly influenced by the economic developments of main export partners Finland and Sweden. In 2017, Estonia was among the fastest growing economies in the EU with a GDP growth of 4.9% (Müürsepp 2018). By GDP per capita, Estonia is on the fourth place after Slovenia, Slovakia and Czech Republic among the Eastern European countries. The main challenges that hinder the success of the Estonian economy are lack of highly skilled employees, lack of innovation, and low international competitiveness.

7.1.5 The Status Quo of Science and Technologies

The economic growth is depending on the state of science and technologies. As a small country, Estonia has to focus its science and research in some key areas. The

Estonian Research and Development and Innovation Strategy 2014–2020 (2014) establishes three selected fields of growth: (1) information and communication technology (ICT), horizontally through other sectors; (2) health technologies and services and (3) more effective use of resources. In the last decade, Estonia has become a base for an ecosystem of IT start-ups. The first success story of the Estonian IT sector was Skype, in which the technical backend was developed by a small team Estonian engineers, before it was acquired by eBay and later by Microsoft. The global economical crisis in 2008–2009 forced financial sector, telecoms and other major IT employers to reduce their workforce which created conditions for the emergence of the start-up sector. Dumas (2014) associates the success of the Estonian start-up ecosystem with three factors that are related to the small size of the country: (1) fewer regulations and barriers, (2) thinking internationally and (3) focusing on developing simplified and agile solutions for complex areas. The most successful current start-ups are a transportation network company Bolt (formerly known as Taxify) and money transfer service TransferWise.

Estonia is also known for its e-governance solutions (Kalja et al. 2013) which rely on the ID-card infrastructure that enables secure authentication of citizens and digital signing of documents on a wide array of e-services both from the public and private sectors. All the state e-services are connected through the X-Road system that enables data exchange between various systems. People can access public e-services and view information stored about them through the state portal. Around 98% of tax declarations are filed through an e-Tax service of the Estonian Tax and Customs Board. The majority of admission applications for universities are submitted through and online system SAIS. In the most recent parliament elections in 2019, 43.75% of citizens voted through an i-voting system (Galano 2019). Private e-services that can be accessed by authenticating with ID-card include online banks, telecom companies and various other companies that have a large number of customers. In 2014, Estonia launched the e-Residency initiative (Kimmo et al. 2018) that enables citizens of other countries to become e-residents of Estonia in order to use the Estonian e-governance services. E-residents are able to use all e-services based on the ID-card infrastructure: authentication, signing documents digitally, establishing and administering a company, using banking services, etc. According to the e-Residency statistics dashboard, more than 50,000 people have been approved as e-residents and they have established over 6000 companies.

7.1.6 The Relationship with China Under the '16 + 1' Cooperation Framework

Estonia is part of China-CEEC 16 + 1 collaboration platform established between China and 16 Central and Eastern European countries in 2012. Estonia has a stable and growing economical relationships with China. In 2017, China was the 9th foreign trade partner for Estonia. Estonian export to China includes electrical equipment,

wood and wood products, and agricultural products. Estonia's geographical location provides possibilities for the logistics sector. Chinese ride-sharing, artificial intelligence and autonomous technology company DiDi is one of the key investors in the Estonian transportation network company Bolt. There is also growing cooperation in education, research and culture. Approximately, 100 exchange students from China are studying in Estonian universities every year. The Confucius Institute was opened in 2010 in Tallinn University to offer courses on Chinese language and Chinese traditional culture.

7.2 Overview of the Educational Development

7.2.1 Education System and Policy

The development of the educational system in Estonia is guided by the Estonian Lifelong Learning Strategy 2020 (2014), which establishes five strategic goals: (1) a change in the approach to learning; (2) competent and motivated teachers and school leadership; (3) the concordance of lifelong learning opportunities with the needs of the labour market; (4) a digital focus in lifelong learning and (5) equal opportunities and increased participation in lifelong learning. The Ministry of Education and Research (MER) has launched a number of specific development programmes under these five goals and the government follows the strategy when making the funding decisions.

General education in Estonia is divided into pre-school, basic and upper secondary education. Pre-school education is provided for children between 18 months and 7 years. Basic education is mandatory for all children and is divided into three stages: stage I (grades 1–3), stage II (grades 4–6) and stage III (grades 7–9). The content and objectives of the basic education are specified in the national curriculum of basic school. In order to graduate the basic school, the students have to complete all the courses of the curriculum and pass three exams: Estonian language (or Estonian as a second language), mathematics and one additional exam chosen by the student. After completing the basic education, it is possible to continue in the upper secondary school (grades 10–12) or in vocational education. In vocational secondary education study programmes, it is possible to obtain upper secondary education in addition to vocational training.

Basic schools and the majority of upper secondary schools are administered by rural municipality or city authorities. In recent years, the MER has started to develop a network of state upper secondary schools with the aim to ensure the high-quality secondary education and a more efficient school network. Currently, there are 15 state upper secondary schools and the ministry aims to have at least one state upper secondary school in each county by 2020. While typical upper secondary schools run by the local municipalities have grades 1–12, new state upper secondary schools have only grades 10–12.

7.2.2 *Profile of School, Students and Teachers*

The Ministry of Education and Research has developed an online portal Haridussilm (EducationEye) that provides annual statistical data about the Estonian education. In 2018/19 school year, there are 518 schools providing general education in Estonia and 160 of these are providing upper secondary education. The number of schools has been declining every year, in 2005/06 school year, there were 602 schools. All together there are 151,000 students in general education and 22,000 of them in upper secondary level. In recent years, the number of students has been slowly increasing. The lowest point was in 2012/13 school year when then were 134,000 students in general education. 84.6% of the students are studying in Estonian and 14.7% in Russian. In 2018, over 11,000 students graduated from the basic school and over 6000 from the upper secondary school.

For a long period of time, the vocational education was perceived as less prestigious than secondary education and students preferred upper secondary schools to vocational schools. After joining the European Union, big investments have been made to increase the quality of vocational education. Currently, there are 38 vocational education institutions with 23,000 students. While in 2007/08 school year, there were 22% more students in upper secondary schools than in vocational education, from 2010/2011 school year, there have been more students in vocational education. Although overall student numbers in vocational education have decreased 14% in the last decade, the decrease has been more significant in upper secondary education (28%).

The higher education is provided in 20 institutions: 6 universities under public law, 8 state professional higher education institutions, 1 private university and 5 private professional higher education institutions. Three largest public universities are University of Tartu (12,000 students), Tallinn University of Technology (10,000 students) and Tallinn University (7000 students). All together there are 45,000 students studying in higher education in 2018/2019 academic year. This number has decreased significantly over the last decade, in 2008/2009 academic year, there were 68,000 students in higher education level. The decrease of student number has mainly affected bachelor's studies and vocational higher education. The number of master's students has increased slightly during the last decade, as many adults return to university to obtain a master's degree in a different field. In 2013, Estonia had a higher education reform with the aim to make higher education free of charge for new full time students admitted to study programmes taught in Estonian. On one hand, this step has improved access to higher education, but on the other hand, it has complicated the financial situation of the universities. The universities have opened international study programmes in English, which also attract foreign students. In last 10 years, the number of foreign students has grown five times, and currently there are about 10% of international degree students in the Estonian universities. The annual enrolment rate in higher education was 14,000 in 2018/2019 academic year. However, the dropout rate is quite high. In 2017/2018 academic year, 9000 students graduated in higher education and 7000 students interrupted their studies.

There are 15,000 teachers working in general education, 2000 teachers in vocational education and 7000 in pre-school education. A critical issue is the age of teachers: 49% of school teachers are 50 years or older. Only 9% of the teachers are under 30 years old. With these numbers Estonian teachers are among the oldest in OECD countries. The ministry has taken measures to rise teachers' reputation and increase teachers' salaries. Despite these attempts, there is still a lack of young teachers in schools and teacher education programmes do not attract enough new students. In 2017/2018 academic year, only 355 students graduated master level studies in teacher education programmes.

7.2.3 Teachers' Professional Development

Teacher education programmes are run by two public universities, Tallinn University and University of Tartu. General requirements for teacher training are established in the Framework for Teacher Training. Teacher training programmes are offered in the master level and consists of core courses in the area of subject, teacher training courses, subject-specific didactics, placement and master's thesis. It is expected that students enrolling the teacher training programme have completed bachelor's studies in the subject area. Teachers graduating the teacher education programmes are certified on the basis of Teacher's Professional Standard. Novice teachers are also expected to complete the induction year during which they are supervised by the mentor. A detailed overview of the Estonian teacher education system is provided by Sarv (2014). In-service teacher training is provided by universities, various foundations and non-governmental organizations according to the conception of teachers' and school heads' continuous education, which sees changing the approach to learning as a main challenge. Although the studies such as TALIS 2013 (OECD 2014) show that teachers believe in constructivist approaching the learning, the actual school practice is slow to change. In-service teacher training must support using ICT in the learning process and developing self-analysis and research skills.

7.2.4 Government Expenditure on Education

The government expenditure on education was 5.8% of GDP in 2017. 59% of the costs went for personnel expenditure, 21% for operational costs, 12% for investments and 8% for other costs. In order to compare the government expenditure on education with other countries, we have to look at the OECD Education at Glance report (OECD 2018, p. 266), which has a different methodology for achieving comparative results. According to OECD report, Estonia's direct expenditure within educational institutions was 4.1% of GDP in 2015, which is below the OECD average. In recent years, the expenditure on general education has increased (from 2.07% in 2012 to

2.20% in 2017) had the expenditure on higher education has decreased (from 1.44% in 2012 to 1.01% in 2017).

7.2.5 Education Research

The structure and operational principles of research and development in Estonia are established in the Research and Development Organisation Act. National R&D development plans are prepared and approved by the government, which is advised by the Research and Development Council. The research policy is implemented by the MER. Positively evaluated research and development institutions include 6 public universities; 1 private university and more than 10 research institutes, museums and private companies. The research activities are funded by the base financing of research institutions, personal and institutional research grants and national science programmes. The national research funding also covers centres of excellence, doctoral schools and expenses of research and development infrastructure. Different competitive funding instruments are managed by the Estonian Research Council. The four main objectives of research and development are established in the Estonian Research and Development and Innovation Strategy 2014–2020 (2014): (1) research in Estonia is of a high level and diverse; (2) research and development functions in the interests of the Estonian society and economy; (3) research and development makes the structure of the economy more knowledge-intensive and (4) Estonia is active and visible in international research, development and innovation cooperation. In order to achieve these goals, the strategy aimed to increase the public research funding to 1% of GDP by 2020. However, it is not realistic as current government expenditure on research and development is 0.81% of GDP, which is considered insufficient by the research institutions.

7.3 New Progress of ICT in Education

ICT in education has been a priority area for Estonia from mid-90 s, when it was understood that the smart use of information technology in various sectors is a success recipe for a small country. In 1996, the Tiger Leap Program was launched to support the development of ICT infrastructure in schools, provide basic ICT training for teachers and develop educational software and learning resources in Estonia. In order to coordinate these developments in general education, the Tiger Leap Foundation was established in 1997. The general level of using ICT in teaching and learning was lower in higher and vocational education, although some innovative lecturers provided online courses already in late 1990s. The Estonian e-University consortium was established in 2003 with the aim to provide more flexible learning opportunities in higher education. The consortium coordinated the licensing and hosting of WebCT learning management system for the partner universities and supported the

sharing of good practice among the educators. The consortium worked in tight cooperation with the Estonian Information Technology Foundation, which coordinated ICT projects in higher and vocational education. In 2013, the Tiger Leap Foundation, Estonian Information Technology Foundation and educational Internet service provider EENet were reorganized and a new coordinating organization Information Technology Foundation for Education (HITSA) was formed. In order to implement the goals of the Estonian Lifelong Learning Strategy 2020, MER has established the Digital Focus programme.

7.3.1 Infrastructure

The general situation of ICT infrastructure in schools can be considered satisfactory, although there is no recent data published about the current situation of the ICT infrastructure. The most recent study about the ICT infrastructure in schools was carried out in 2014 by the HITSA foundation (HITSA 2014). According to the study, the average student–computer ratio in schools was 13.9. About 30% of the computers were located in computer labs, the rest were in other classrooms or in personal use of teachers and school administration. At average, 90% of the computers were connected to Internet, which means that in schools there are still rooms without proper Internet connection. About half of the computers used by the students are relatively new: 45% of computers were up to 3 years old and 37% of computers were between 4 and 6 years old. The computers used by the teachers and the school administration were slightly older: 39% of computers were up to 3 years old and 41% of computers between 4 and 6 years old. Still, almost 20% of computers in schools are older than 6 years. Large schools with more than 600 students are able to upgrade the computer labs more frequently. In 2018, the MER had a project for updating the ICT infrastructure in schools, which included purchasing 4900 laptops, 2100 desktop computers and 480 multimedia computers for schools. In recent years, some schools have invested also in tablet computers, although the majority of schools have taken BYOD approach in which the students will bring their own device to the school. In 2014, the student–tablet ratio was 81, which means that most of the schools do not have sufficient number of tablet computers to be used in lessons. However, in this case, the average number might not indicate the real situation, as some schools have invested in a set of 30 tablets that can be used with the whole class while other schools have just a few or no tablets at all. Another technology that has gained use in Estonian schools is interactive whiteboard. In 2014, 10% of classrooms had an interactive whiteboard installed. In state upper secondary schools, every fifth classroom had an interactive whiteboard. While interactive whiteboards were still in a minority of classrooms, video projectors were installed in 65% of the classrooms according to the study.

One of the areas that need improvement is the network connection speed. An analysis carried out in 2014 indicated that 80% of schools have a network connection speed slower than 30 Mbit/s, which is not sufficient for using modern media rich online services in the classrooms. In order to improve this situation, the Ministry of

Economic Affairs and Communications has launched a programme for modernizing the ICT infrastructure of general schools in 2016–2020. During the first 3 years of the programme, the work has been completed in 159 schools, where the local area network cabling was renovated and network equipment was replaced.

7.3.2 Educational Resources

Digital educational resources

The development of digital learning resources in Estonian has been a focus since the Tiger Leap Program in late 1990s. Looking at the use of digital learning resources in schools, we can identify three phases. In late 1990s and beginning of 2000s, the focus was on the use of educational software that was mainly produced by the Estonian universities or by foreign educational content publishers. In 2001, the national educational portal Koolielu (Schoollife) was launched, which provided a repository platform that enabled teachers to publish their own learning resources. In the second phase from mid-2000s to mid-2010s, the main focus was on the content developed by the teachers. In general education, this process was supported by various teacher trainings and competitions which motivated teachers to create and share their resources. In vocational and higher education, there were a number of projects in which the lecturers were paid for developing digital learning objects and course modules. While this approach provided a large number or resources developed by the educators, the quality of this content varied and lecturers of higher and vocational education institutions stopped sharing their resources when the funding for content development ended. In recent years with the Digital Focus programme, the MER has taken an approach to combine professionally developed content by the textbook publishers with user-generated content from the teachers. Since 2015, the textbook publishers are required to make the digital versions of their textbooks available for schools. To provide a common platform for textbook publishers and teachers, the MER launched e-Koolikott (e-Schoolbag) repository in 2016. The largest textbook publisher Avita has developed a platform Opiq, which contains 140 digital textbooks, mainly for the basic school level. In order to cover upper secondary school curriculum with digital learning resources, MER contracted with Tallinn University, which coordinated a large content development project in which more than 120 experienced subject teachers were hired to develop digital learning resources for schools. As a result, the teachers developed more than 10,000 resources using H5P authoring platform.

Open educational resources

The concept of open educational resources (OER) is understood by the key people who are involved in shaping the policies for ICT in education. As a result, Creative Commons licenses were introduced to learning resource repositories in late 2000s and localized to Estonian in 2010. e-Koolikott repository contains more than 18,700 resources, 11,700 of these are under Creative Commons licenses. Usage statistics from the repositories show that the teachers in general education are more open to

share their learning resources as OERs. In vocational and higher education, Creative Commons licenses are often chosen because of the funding requirements and in that case more restrictive license types are preferred. For example, in HITSA foundation's repository, which focuses on higher and vocational education, 46% of resources are under the most restrictive CC BY-NC-ND license, followed by 41% of resources under CC BY-NC-SA license. In e-Koolikott, which focuses on general education, the most commonly used license is CC BY (61% of OERs), followed by CC BY-NC-SA (28% of OERs). In recent years, the MER has required that content which is developed with public funding must be distributed under Creative Commons licenses. This has resulted the growth of OERs and shift towards more liberal licenses, as the most recent content development projects have required the use of CC BY license.

7.3.3 ICT Integration into Learning and Teaching Practices

In the national curriculum for basic schools, digital competence is listed as one of the eight general competences that is developed through all subjects and in extracurricular activities. For more than a decade, the main focus has been on teaching digital competences through other subjects. Informatics is listed as an optional subject, which the schools are not required to offer. The national curriculum describes the learning outcomes of school informatics for the second (grades 4–6) and third (grades 7–9) stage of general education and outlines two courses: (1) computer as a means of work and (2) information society technologies. The schools are free to develop and provide additional informatics courses as well. However, a recent study carried out by Tallinn University in 2018 found out that more than half of the schools involved in the study do not provide any informatics courses. One reason for this is lack of informatics teachers in schools. Subject teachers are able to teach basic digital competences through using ICT in their subjects, but this is not sufficient for more technical courses such as programming, robotics, 3D modelling or web design.

In recent years, a special attention has been given on teaching programming and robotics in the schools. In 2012, ProgeTiger programme (HITSA 2015) was launched to enhance learners' technological literacy and digital competence. The programme aims to combine engineering sciences, design and technology, and information and communication technology. The programme targets both teachers and learners by developing learning materials, providing trainings for teachers, supporting various networking activities, providing financial support for purchasing various equipment (robotics kits, sensors, 3D printers, etc.) and sharing information.

A study of teaching digital competences in general education and pre-school education (Leppik et al. 2017) summarized three main conclusions: (1) the approach to teaching digital competences varies a lot between the different schools; (2) availability and quality of digital tools and learning resources is key obstacle for teaching digital competences and (3) although teachers and students have a positive attitude towards using digital technologies in teaching and learning, the digital tools

are not sufficiently used in practice. The study indicates, that teachers of mathematics (67%) and natural sciences (58%) found the most that teaching ICT competences is integrated with their subject. 78% of teachers use computers and 70% of teachers use presentation tools regularly in their teaching. From the students' perspective, it is important to point out the use of smartphones in lessons: 57% of students use smartphones at least weekly for learning in lessons. Regarding digital learning resources, 78% of teachers have used their own learning resources and 72% of teachers have used resources found from the Estonian educational repositories. The main types of digital learning resources developed by the teachers include worksheets, presentations, quizzes, interactive exercises and videos.

Monitoring the ICT integration into teaching and learning in a state level is a challenge. Tallinn University has developed a framework and online tool for assessing the school's digital maturity. The assessment framework covers three domains: digital infrastructure development, pedagogical innovation and change management in the school. Currently, more than 80% of the schools in Estonia have completed the self-assessment and composed the digital development plan for their school using the Digipeegel (Digital Mirror) online tool. In order to improve the reliability of the data, the self-assessment can be validated through peer evaluation by another school or expert visit. Digital development plans created in Digipeegel are public, so that schools can learn from each other.

In vocational and higher education, a common way of using ICT is to develop an online course either for supporting traditional face-to-face course or providing the course completely in a distance education form. In order to support the development of online courses, the e-University consortium has coordinated the development of various guidelines and established the e-learning quality label process (Plank et al. 2013) which combines self-evaluation, evaluation from the organization and from the experts. 39 courses were awarded with quality label in 2018. The most widely used online learning platform in higher and vocational education is Moodle, which is hosted centrally by the HITSA foundation. Tallinn University has developed an online learning platform eDidaktikum, which is used mostly for teacher education. MOOCs have not been adopted very widely, although there are several successful cases from University of Tartu (Leito et al. 2015; Lepp et al. 2017). Lecturers in Tallinn University have experimented with more learner-centred approaches such as using personal learning contracts (Väljataga and Laanpere 2010), using blog-based learning environments (Põldoja et al. 2016a; Tomberg et al. 2013), and awarding learners with open badges (Põldoja et al. 2016b).

7.4 ICT Related Policies and Financing Resource

The main development strategy and funding instrument for ICT in education is the Digital Focus programme. According to the Estonian Lifelong Learning Strategy 2020, the five strategic measures of the Digital Focus include (1) incorporating a digital culture into the learning process; (2) supporting digital learning resources in

schools; (3) accessing a modern digital infrastructure for learning; (4) creating and implementing assessment models for digital competence and (5) creating learning opportunities for adults to acquire digital competences. The action plan of Digital Focus programme for 2018–2021 focuses on two measures: incorporating a digital culture into the learning process and creating preconditions for that. In order to integrate digital culture into the learning process, it is planned to develop curriculum and study programmes, support innovative learning activities, develop teachers' digital competences and provide educational technology support, and to develop the e-assessment methodology. Creating preconditions for these activities involve developing new and innovative digital learning resources, integrating the e-services used in education and improving the network connectivity in schools. The annual budget for these activities varies between 7.3 and 8.8 million euros. This funding is targeted mainly on general education, although the universities are involved in the research and development activities of the Digital Focus, such as coordinating the development of digital learning resources.

IT Academy programme focuses specifically on improving the quality of ICT education in higher education. The programme provides funding for ICT research in the universities, supports the students of ICT study programmes with scholarships and finances development projects for improving the quality of ICT study programmes and teaching subject-specific ICT skills in non-ICT study programmes. IT Academy programme is managed by the HITSA foundation in collaboration with MER, universities and ICT companies. The annual budget of IT Academy programme is 3.4 million euros.

Since joining the European Union in 2004, the resources of European structural funds have also played an important role in improving the education in Estonia. All together, more than 820 million euros have been invested in educational sector. Measures under education include development of educational support services, professional development support for teachers, development of innovative learning resources and other measures that can be associated with ICT in education. The area of information society has received more than 170 million euros, mainly for the development of ICT infrastructure and smart services.

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