Scientific Research on the Effects of the Project "e-Schools: Establishing a System for the Development of Digitally Mature Schools (Pilot Project)"

(151 selected schools)

Initial Research Report

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1. INTRODUCTION

1.1. ICT's Two Sides of the Same Coin - Revolutionising and Dividing

By the end of 2016, 3.9 billion people - 53% of the world's population – is not using the Internet, estimates the Information and Communication Technology Data and Statistics Division of the International Telecommunication Union (ITU, 2016a). Clearly there is a 'digital divide' many authors discuss and warn about (Blau, 2002; Chinn & Fairlie, 2004; Compaine, 2001; Hilbert, 2010; Mossberger, 2003; Mossberger, Tolbert, & Gilbert, 2006; Norris, 2001) because at the same time more than 3 billion people are using the Internet, according to the United Nations agency that oversees international communications. In fact, the number of Internet users has increased from 738 million in 2000 to 3.2 billion in 2015, according to a new report from the International Telecommunication Union.

Since the invention of the microcomputer some 30 years ago, the number of computers in use worldwide has been growing at an exponential rate. By mid-2010, it was estimated that almost two billion people, or 29% of the world population, were using the Internet, with percentages ranging from 77% in north America to about 11% in Africa (Miniwatts Marketing Group, 2010). The past decade has also seen the explosion of mobile technologies with laptops, digital pads, smart phones and other portable digital devices being sold in increasingly large numbers. ITU statistics reveal that only around 11.9% of the global population is connected to fixed-line broadband, but mobile broadband connection is estimated at 49.4%, pointing to the importance of mobile Internet access (ITU, 2016b).

More than a buzzword, the "digital divide" has come to represent a growing problem and an unstoppable tendency in our world. Both problem and tendency are constantly evolving, shifting scope and bringing more variables to the table. Its

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definition isn't static, however, digital divide is usually referred to in literature as an economic and social inequality with regard to access to, use of, or effect of information and communication technologies (ICT). Some research argue that the digital divide is more than just an access issue and cannot be alleviated merely by providing the necessary equipment (Mossberger, 2003; Mossberger et al., 2006; Mun-cho & Jong-Kil, 2001). There are at least three factors at play: information accessibility, information utilization and information receptiveness. More than just having access to ICT and Internet, individuals need to know how to make use of the information and communication tools once they exist within a community (Mun-cho & Jong-Kil, 2001) to be capable of becoming a 'digital citizen'. To be digitally competent or to be 'digital citizens' as Mun-cho and Jong-Kil (2001) put it means having: a) instrumental knowledge and skills for digital tool and media usage, b) advanced skills and knowledge for communication and collaboration, information management, learning and problem-solving, and meaningful participation, and c) attitudes for strategic skills usage in intercultural, critical, creative, responsible and autonomous ways (Ala-Mutka, 2011). Digital competence is no longer linked to the access and use of technologies but also includes the capacity to benefit from them for life, work and learning. What is therefore at stake here goes beyond pure digital divide, meaning access to ICT and information available. As some authors claim (Mossberger et al., 2006), it is actually individual social and cultural capital at stake. Since gender, age, racial, income, and educational gaps in the digital divide have lessened compared to past levels, some researchers suggest that the digital divide is shifting from a gap in access and connectivity to ICTs to a 'knowledge divide' (Graham, 2011). A knowledge divide concerning technology presents the possibility that the gap has moved beyond access and having the resources to connect to ICTs to interpreting and understanding information available around.

Digital divide is much present within the EU countries themselves, as a recent study on the EU population reports (European Commission, 2014). Results show that 23% of the EU population has no digital skills - ranging from only 6% in Sweden to half of

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Romania's population. Considering that to function effectively in the digital society one needs at least medium level or "basic" skills, digital divide reveals quite worrisome data - almost half the EU population (47%) do not attain this level of skill having either "low" or "no" digital skills at all.

Studies and reports reveal large cross-country differences in ICT availability (and use) among European students as well. On average, 88.3% of European students have access to and use Internet at home - this percentage is above 95% in all the Nordic countries (it is highest in the Netherlands with 98.6%) and it is below 80% only in Bulgaria (79.1%) and Greece (68.1%). In all countries but Poland, the share of students using Internet or email at least once a week for entertainment is well above the share of students using these media for school-related purposes. Only in Portugal and Slovakia do students report using email for schoolwork in more than half of the cases (54.2% and 50.3%, respectively). In nine countries (Belgium, Bulgaria, Denmark, Estonia, Hungary, Netherlands, Poland, Portugal, Norway) the majority of students report browsing the Internet for school work, while in seven countries (Denmark, Estonia, Slovenia, Finland, Sweden, Iceland, Norway) nine tenths of students report browsing for fun (Biagi & Loi, 2012).

However, being fully aware of the digital divide, the ICT truly represents inevitable and integral component of a modern world which is entwined into virtually every aspect of human life. Hawkridge (1983) refers to ICT as a revolution which has penetrated almost all fields of human activity, thus transforming economic and social life. Helmut (1998; as cited in Akpore, 1999) states that out of the technological changes that have influenced our lives in recent years, ICT has had the greatest effect. Martin (1995) agrees describing how we live in a society in which the quality of life, as well as any prospects for social change and economic development depend increasingly upon information and its exploitation. In such a technology-driven society, continues Martin (1995), living standards, patterns of work and leisure, the education system, and marketplace are all influenced by advances in ICT and knowledge. Some claim that ICTs are crucially important for sustainable

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development in developing countries (Crede & Mansell, 1998), and that significant changes most developed countries have witnessed in almost all aspects of life - economics, education, communication, and travel - can be all traced to ICTs (Thioune, 2003).

ICT is an important part of our social lives as well. For the past two decades some researchers claim that it is a serious threat to the quality of our interpersonal relationships, especially among the youth (Bastian & Taylor, 1991; Opotow, 1990; Woody, 2001), some that the excess use of technology may underhandedly inhibit proper interpersonal skill development (Wolak, Mitchell, & Finkelhor, 2003). In particular, growing concern exists among researchers regarding the effects of the Internet on youth regarding potential risks to safety, well-being, and skill development (Caplan, 2003; Gross, 2004; Selfhout, Branje, Delsing, Bogt, & Meeus, 2009). Researchers have sought to learn more about problematic Internet use and one of the most consistent themes to emerge from the literature is that individuals who report negative outcomes associated with their Internet use appear to be especially drawn to its interpersonal functions (Caplan, 2002, 2003; Chak & Leung, 2004; Davis, Flett, & Besser, 2002; McKenna & Bargh, 2000; Morahan-Martin & Schumacher, 2000, 2003; Van den Eijnden, Meerkerk, Vermulst, Spijkerman, & Engels, 2008; Young, 1998; Young & Rogers, 1998). McClellan (1994) claims that the character of virtual communities can be as provincial and dangerous as small town communities. He criticizes cyberspace communities as pseudo communities that have only the appearance of true social bonding. He states: "Rather than providing a replacement for the crumbling public realm, virtual communities are actually contributing to its decline. They're another thing keeping people indoors and off the streets. Just as TV produces couch potatoes, so does an on-line culture as it creates mouse potatoes, people who hide from real life and spend their whole life goofing off in cyberspace" (ibid, p. 10).

On the other side, some authors emphasize the ICT's benefits in terms of easy and almost instant communication over long distances (Wellman & Haythornthwaite,

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2008), as well as enormous benefits in terms of lifelong, particularly distance learning (Haythornthwaite & Andrews, 2011). These authors argue the powerful potential ICT has for extending educational opportunities, both formal and informal, to previously underserved constituencies—scattered and rural populations, groups traditionally excluded from education due to cultural or social reasons such as ethnic minorities, girls and women, persons with disabilities, and the elderly, as well as all others who for reasons of cost or because of time constraints are unable to enroll on campus.

Despite the lack of consensus among researchers and continuous 'battle' among studies that simultaneously report advantages as well as disadvantages of the ICT, one thing is certain - the rapid growth in ICT has brought remarkable changes in the 21st century, as well as affected the demands of modern societies. The ICT is becoming increasingly important in our daily lives, our working environment and in our educational system. It is therefore hard not to agree with some authors who claim a growing demand on educational institutions to use ICT to teach the skills and knowledge that students need for the 21st century (Buabeng-Andoh, 2012). Even more, it is difficult and maybe even impossible to imagine future learning environments that are not supported, in one way or another, by the ICT. When looking at the current widespread diffusion and use of ICT in modern societies, especially by the young – the so-called digital generation – it should be clear that ICT will affect the complete learning process today and in the future (Punie, Zinnbauer, & Cabrera, 2006).

In today's information society, the attainment of digital proficiency is an absolute prerequisite. Modern societies need to build workforces which have ICT skills to handle rapidly growing information and which are reflective, creative and adept at problem-solving in order to generate knowledge. This changes therefore require of the education itself to re-think what skills and competencies students need in order to become active citizens and members of the workforce in a knowledge society (Hine, 2011).

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1.2. ICT Revolutionising Teaching and Learning?

The utter relevance of the ICT in modern life is especially true for today's school-age children and youth that were born into this (digital) world, and that cannot imagine their own lives without PCs, laptops, tablets, smartphones etc. These children are often referred to as 'digital natives', as opposed to 'digital immigrants' (Prensky, 2001).

The rationale behind Prensky's concept of new generations being 'digital natives' ("native speakers" of the digital language) is multifaceted, but plausible and 'backed up' with studies from various disciplines and fields (e.g., education, psychology, pedagogy, neuro and brain studies) as well as with those interdisciplinary oriented ones, and therefore worthwhile of a (brief) introduction. Prensky (2001) claims today's students have changed so radically that they defy the very original setting of a today's educational system, or - as he phrased it - "they are no longer the people our educational system was designed to teach". He argues that such a big discontinuity between today's students and previous generations has taken place and thus changed things fundamentally, without any possibility of going back. For that discontinuity he "blames" the arrival and rapid dissemination of digital technology in the last decades of the 20th century. Discontinuity took place as today's students – from kindergarten to university level – represent the first generations to grow up with all the new technology attributed to a 'digital world' - they have spent their entire lives surrounded by and using computers, videogames, digital music players, video cams, cell phones, and all the other toys and tools of the digital age. As a result, today's students thinking patterns as well as those of the information processing, differ fundamentally in comparison to both thinking and processing patterns of their predecessors.

Digital learners are different from previous generations for several reasons: a) they are multiliterate (Hofstetter, 2000), b) they fuse web surfing for learning and entertainment (*infotainment*), c) their reasoning is based on *bricolage,* understood

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as "abilities to find something - an object, tool, document, a piece of code - and to use it to build something you deem important" (Brown, 2000, p. 13), and d) they learn in situated actions. Their lives are characterized by immediate communication and an active use of digital media that has changed their notions of communication, knowledge management, learning, and their personal and social values (Fructuoso, 2015). As already stated, in modern society, the attainment of digital proficiency is absolutely necessary in order to build workforces with appropriate skills and knowledge.

Hence, it is of no surprise that economic and social development have urged governments to emphasize the contribution of education to a wide range of required skills and competencies. The recommendations of the European Parliament and the Council on key competences for lifelong learning identify a framework of eight competences necessary in a knowledge society (European Commission, 2006). Digital competences, defined as the confident and critical use of Information and Communication Technologies (ICT) for work, leisure and communication, are highlighted as one of these eight key competences. The central role of new technologies and digital competences for active citizenship, social cohesion, employability and economic development is further reaffirmed in the recently adopted initiatives "New Skills and Jobs" (European Commission, 2010a) and "Digital Agenda for Europe" (European Commission, 2010b). Education has obviously (and once again) being recognized for its unique role to play in providing young people with the skills needed in a society in which ICT-related skills and competences are increasingly indispensable. It is of no surprise then that educational and governmental stakeholders have regarded digital technology as the 'holy grail' for revolutionising teaching and learning (Buabeng-Andoh, 2012).

At the same time, there has been an increasing interest in various applications of ICT in education, following the notion of its contribution to enhancement of teaching and learning in schools. Recent studies and various reports claim at least six major reasons pushing such mountaineering interest. Firstly, the ICTs can improve access

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to and promote equity in education by providing educational opportunities to a greater number of people of all ages, including those traditionally unserved or underserved groups (e.g., those in rural and remote areas, women and girls, and persons with disabilities). Secondly, the ICT opens up an access to information, and provides opportunities to widen access to education (OECD, 2015a, 2015b). Thirdly, the ICTs can enhance the quality of teaching and learning by providing access to a great variety of educational resources and by enabling participatory pedagogies. This means that ICT provides new ways of supporting learners as it changes pedagogies and methods of teaching and learning. Fourthly, the ICT has the potential to change the nature of disciplines as it changes the sorts of questions you can answer, the ways in which you go about answering them, and the ways in which you represent your understandings. Fifthly, the ICTs can improve the management of education through more efficient administrative processes, including human resource management, monitoring and evaluation, and resource sharing. And last, but not the least, ICT has already been an integral part of the daily lives of children. There is therefore a need to develop learners who can work critically and function in an ICT-rich, connected society, as Pérez-Sanagustín and associates (2016) claim.

Several studies argue that the use of new technologies in the classroom is essential for providing opportunities for students to learn to operate in an information age. It is evident, as Yelland (2001) argued that traditional educational environments do not seem to be suitable for preparing learners to function or be productive in the workplaces of today's society. She argues that organisations that do not incorporate the use of new technologies in schools cannot seriously claim to prepare their students for life in the 21th century.

However, ICTs are not a panacea or cure-all for gaps in education provision. The right conditions need to be in place before the educational benefits of ICT can be fully harnessed, and a systematic approach is required when integrating ICTs into the education system. This fact is often overlooked and, in their eagerness to jump on to the technology bandwagon, many education systems end up with technologies that

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are either not suitable for their needs or cannot be used optimally due to the lack of trained personnel. Such 'eager to jump on board' strategy has resulted with the physical presence of technological devices and programmes increasing at an extraordinary rate in schools (Buabeng-Andoh, 2012). As with all major school initiatives, it is about institutional capacities in whole to introduce the initiative - one being innovative or already known - and to make its presence long-term and sustainable.

1.3. ICT (Still) as an Innovation in School System

ICT has the power to facilitate vast changes in instruction, in home, community, and school relations, and in school management as well. Venezky and Davis (2002) argue that it should not be viewed as a simple tool, to be considered only after changes are planned, but as a more powerful ally that can help schools aspire to and reach the highest goals of education. Furthermore, once reform with ICT is implemented, a climate for innovation may remain wherein ICT can act as a catalyst for further changes.

Following the fact that ICT may and should be considered as an innovation in whole, not just a tool, it is of great importance to frame it within the context of Rogers's Theory of innovation diffusion (Rogers, 1962/2003). Namely, the way of implementing such a complex innovation is extremely important, and this is where Rogers' theory may prove to be valuable. In a broad sense, this theory answers the questions how, why, under what circumstances and in what time frame new ideas are diffused in a culture or social system/organisation. Rogers (1962/2003) defined diffusion as a process through which innovation is implemented and adopted by members of a specific system, in a certain period of time and through chosen communication channels (Figure 1).

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Figure 1. *Innovation Diffusion Model: Innovation Adoption in Function of Time (Rogers, 1962/2003)*

Adoption Over Time
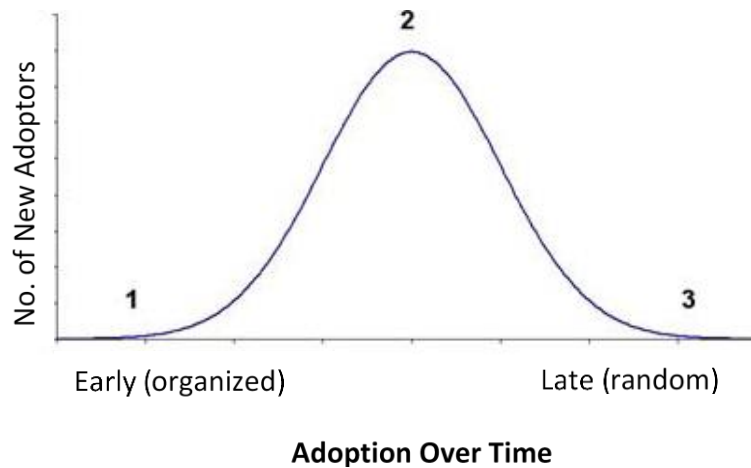
According to the Theory, in every societal system, the actors (i.e. potential adopters) can be differentiated in terms of their readiness to implement innovation into their everyday work. More than 8000 scientific studies which used this framework to analyze, describe and explain different phenomena and innovation diffusion in various systems, show that in every population this 'factor of innovativeness' follows the law of normal distribution (Nutley & Davies, 2000).

The Theory defines five basic elements which influence the diffusion of any new idea:

a. Innovation

The nature of the innovation itself determines the level of its adoption. Rogers recognized five key characteristics of an innovation which can affect the process of innovation diffusion. These include relative advantage to the idea preceding it, compatibility with existing needs and values, complexity, trialability, and observability of results. For more details on these five characteristics, see section 'Teachers' perceptions, beliefs, and attitudes'.

b. Actors (individuals, potential adopters)

Actors can be categorized into five groups – innovators (2.5%), early adopters (13.5%), early majority (34%), late majority (34%), and laggards (16%) (Rogers,

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1962/2003). Although there is currently no data on the frequency of these groups in Croatian teachers, the overwhelming evidence of universality of this distribution justifies the expectation that within the population of Croatian teachers the ratios are equivalent. In this context, out of 50 000 teachers currently employed in Croatian elementary and high schools, only about 7500 teachers are truly opened for integrating innovative ICTs in their work. A more detailed discussion on the importance of this element is presented later in this section.

c. Communication channels

The diffusion is, by definition, mediated by interaction between individuals or organizations. Communication channels enable the information transfer from one unit to another (e.g., teacher to teacher, school to school). In order for even a minimal adoption of a certain innovation to happen, patterns of communicational strategies must be in place.

d. Time

For successful implementation of any innovation, a certain time period is necessary. Innovations are rarely spontaneously adopted. To this date, studies have shown that innovation diffusion can last up to several decades (OECD, 2007).

e. Societal System

Within the Theory, a system is any organizational unit where innovation is implemented. Since every such system is a resultant of external (e.g., educational policies) and internal influences (e.g., decision making style, pattern of communication, relationships between actors), the process of innovation diffusion also depends on these factors.

As previously mentioned, all members of a system in which the innovation is introduced can be categorized in one of five groups which differ in their readiness and openness for accepting the innovation. The frequency of people which fall into

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these groups follows a normal distribution, as can be seen in Figure 2: innovators (2.5%), early adopters (13.5%), early majority (34%), late majority (34%), and laggards (16%).

Figure 2. *Distribution of Five Groups According to the Theory of Innovation Diffusion*
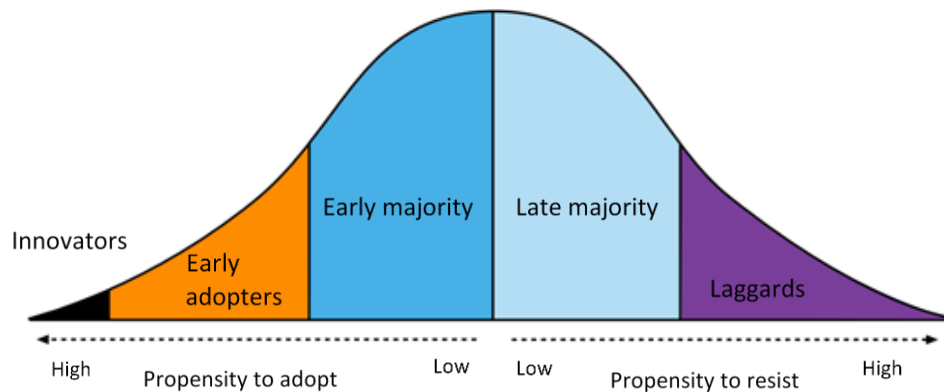
Innovators represent the smallest group of people in any social system or organisation studied (Figure 2). They are proactive, ready to put new ideas to the test, tolerant to difficulties, and are not especially concerned about uncertainty that accompanies innovations. Their boldness and willingness to take risks make them a valuable category in the process of innovation diffusion since they are commonly responsible for launching it into the system.

Early adopters are also quite small as a group (Figure 2), while, at the same time, they might be the most important group in the innovation diffusion process. These actors easily grasp new ideas, have good leadership skills, and are high on empathy. They are perceived as positive role models, which is why they are crucial for innovation diffusion process.

Early majority includes those members which accept new ideas slightly sooner than average, but quite later than innovators and early adopters. They usually postpone their decision to adopt an innovation in order to benefit from the experiences of the previous two groups. They avoid leadership positions and prefer to be the followers of a successful initiative.

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Late majority is a group composed of those actors that embrace new ideas later than an average member of a system. Their adoption of an innovation is usually motivated by economic reasons or frequent pressures from colleagues or their superiors.

Laggards are extremely cautious when it comes to new ideas and changes. If they ever accept an innovation, they will definitely be the last ones. Individuals representing this group avoid changes and are skeptic both toward the innovation and early adopters because of their belief that they are inappropriate sources of information and that they pressure other members in the system to accept the innovation. Because of their characteristics, some authors refer to them as conservative group of people (Lozano, 2006).

As previously stated, the key to successful innovation integration is to detect the early adopters. The fate of the innovation is determined by its acceptance of this group. The characteristics of groups and their interaction explain the 'domino effect' of innovation diffusion. In other words, innovation diffusion depends on very small group of members, popularly called 'the tipping point' (Gladwell, 2002). Why has the tipping point become such a popular idea? Carefully researched analysis has shown that it is an undeniable phenomenon that once understood provides simple and valuable prescriptions for efforts in encouraging diffusion. Therefore, Rogers argues that efforts should be concentrated on those which are genuinely prone to changes and are respected by their colleagues. Besides that, institutional support is needed in order for their full potential as agents of change is accomplished. After the early adopters are convinced in the benefits of an innovation, they will progressively integrate it into other groups as well. The exception is group of laggards, which are not very likely to ever accept an innovation. This is why, according to Rogers (1962/2003), this group should be 'left alone'.

The process of innovation diffusion can be analyzed as a process of individual decision making in five phases (Figure 3):

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a. **Awareness/knowledge:** An individual becomes aware of the existence of innovation and holds an idea of its nature and purpose.

b. **Interest/persuasion:** An individual acquires positive or negative attitude toward the innovation.

c. **Evaluation/decision:** An individual engages in activities in order to base his/her decision on acceptance or rejection of innovation.

d. **Trial/implementation:** An individual uses/consumes the innovation.

e. **Adoption/confirmation:** An individual evaluates the results, keeps or changes the attitude toward the innovation, and makes new decisions.

Figure 3. *Five Stages in the Process of Individual Decision Making on the Acceptance/Rejection of an Innovation*
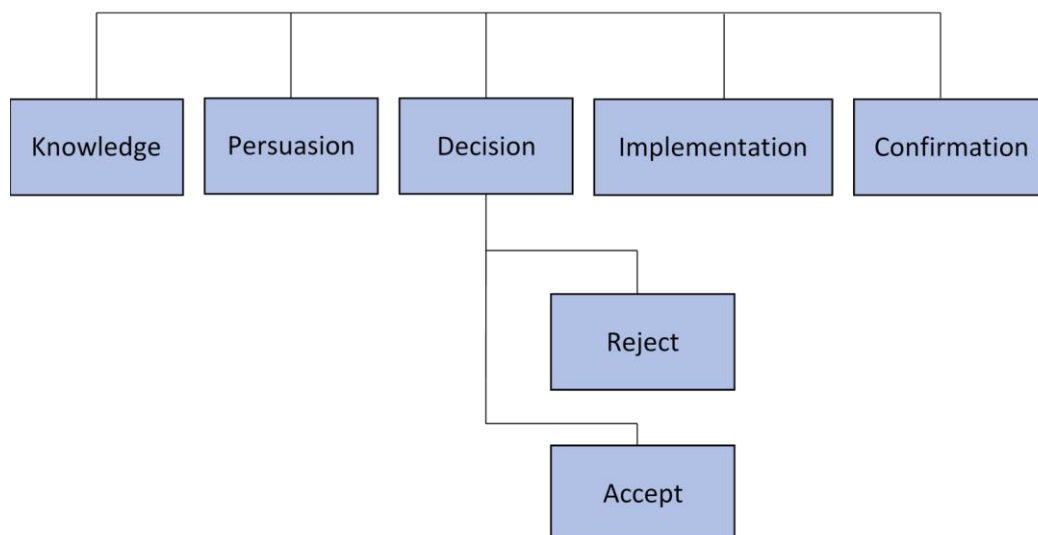
During the first phase (awareness/knowledge), an individual is exposed to an innovation for the first time and does not have enough information about it. In this phase, he/she is not motivated enough to seek additional information independently. In the second phase, an individual gains evidence on the possibilities that the innovation offers, and develops an interest to find further information in order to have more knowledge about it. During the third phase, an individual evaluates the concept of change, and weighs its benefits and drawbacks and makes a decision on accepting or rejecting it. In the fourth phase, he/she starts using the

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innovation, and the level of use depends on a number of (mostly contextual) factors. The person actually evaluates the usefulness of the innovation and often looks for more information to gain certainty in the decision. Naturally, according to the results, an actor can reject the innovation at any point in the process. Finally, in the fifth phase, he/she makes a final decision on further use of the innovation. This phase is also an intra- and inter-personal confirmation that the 'right' decision was made about the acceptance of an innovation. The whole model of innovation diffusion is shown in Figure 4. As it can be seen, implementing any innovation is an extremely complex process, dependent on number of factors on several levels, which all takes considerent amount of time.

Figure 4. *A Conceptual Model of Innovation Diffusion (Rogers, 1995)*

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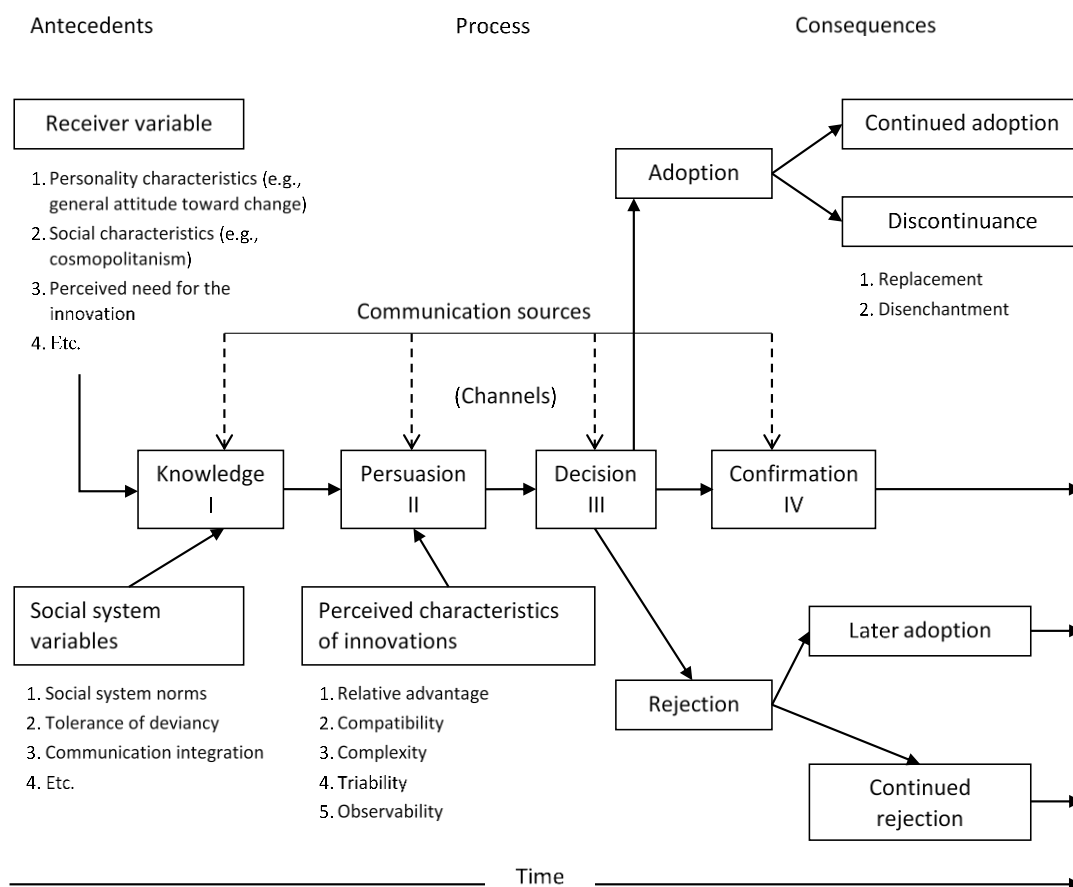
1.4. Approaches to ICT Integration in Education - 'Fancy' Technology or a Mean Within the Education Transformation?

In much research on the integration of ICT in education, different approaches, stages or phases are discussed, analyzed and identified, because it is argued that what counts is not the ICT type and access, nor is it enough for teachers to have ICT competencies, but the implementation process altogether is what counts (Tubin, 2006). Therefore, some suggest to analyze ICT-based innovations on a continuum ranging from the assimilation level through the transition level and up to the transformation level (Mioduser, Nachmias, Tubin, & Forkosh-Baruch, 2003). UNESCO identifies four categories or stages of development concerning ICT use in education: emerging, applying, infusing and transforming (UNESCO, 2005). At the transforming stage of ICT-mediated teaching and learning pedagogies, students' thinking processes are supported by ICT (SEAMO, 2010). The pedagogies adopted by educators at this stage are situated in the constructivist paradigm where learning is perceived as an active construction and reconstruction of knowledge, and teaching is a process of guiding and facilitating students in the process of knowledge construction individually and collaboratively (SEAMO, 2010; Steffe & Gale, 1995).

It is important to distinguish and clarify different approaches of how ICT is represented in education. Zhang (2007) distinguishes between an approach where ICT is seen as the object of education with a purpose to learn about ICT and to get technically skilled, an approach where ICT is used to strengthen expositive teaching, and an approach where is strived for innovative teaching practice, harnessing the full potentials of ICT. Also capability theory refers to the potentials of ICT for educational change and understands ICT as tools to reach an end (Alampay, 2006). Mills and Tincher (2003) formulated and validated a developmental model for technology integration, based on stages, standards and indicators of their technology professional development initiative. They organized standards into phases to reflect a development approach "from novice technology facilitators who use technology

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as a tool for the delivery of instruction to expert technology integrators who are being the technology – augmenting student learning with technology" (Mills & Tincher, 2003). Another relevant categorization on use of ICT in education is that of Maddux and Johnson (2005), who differentiate between ICT applications of type I and of type II: Type I applications are those educational applications that simply make it easier, quicker, or more convenient to continue teaching or learning in traditional ways; type II applications are those educational applications that make available new and better ways of teaching or learning.

Others see the potential of ICT not only to innovate teaching practice, but also to change the curriculum. Bull, Bell, and Kajder (2003) identify two approaches to the use of technology that derive from employing the technology to deliver the existing content more efficiently or alternately to employ the innovation to re-conceptualize aspects of the existing curriculum. Gareis and Hüsing (2009) argue that the transformational potential of ICT is rooted in its effect in terms of empowerment of users, by opening up new, more effective ways for achievement of goals rather than simply making existing structures and processes more efficient. Bowes (2003) argues that effective use of ICT in classroom practice depends on teachers explicitly addressing the question in what way, if at all, the use of ICT can value, given a student learning outcome.

ICT ideally supports both teachers' professionalism and students' ability to become independent learners. This means using ICT for enhancing inquiry and data based decisions, the freedom to make mistakes, the opportunity to work with experts out of school, and assuming responsibility for the outcomes (Tubin, 2006). Most authors agree that the purpose of technology integration in education is to achieve learning goals and enhance learning - not to use fancy technology tools (Liu & Velasquez, 2003). In the context of rapid changes in contemporary society, to engage students in their learning and adequately prepare them for future is a radical challenge for the education systems. Students should learn digital competences with the help of new ways schools developed to stimulate their development. Students should be a part

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of active, personalised and collaborative learning environments, so they can develop the knowledge and key competences needed in today's societies.

1.5. What Can Make ICT's Integration in a School System Successful?

Most countries in the world are pushing for reforms to change the educational system. Timmermann (2010) argued that there are two main reasons for such "pressure" - the economic reason (innovation and productivity improvement to be more competitive in the global economy) and cultural one (preserving identity and roots in a globalized world). Although teachers and school administrators are being pushed to be innovative and to integrate both ICT equipment and relevant practices into their classrooms, delivery centred teaching is still prevailing in most of the schools worldwide. The use of technology to teach seems to be part of a big theoretical discussion, but its application is still minor, as Timmerman (2010) claims. Instead of promoting creativeness and collaborative problem sol ving activities, the idea of learning through sitting in a classroom, memorizing, becoming an autonomous problem-solver and applying standardized tests to measure the quality of education is still the "silver bullet" used to teach, making undifferentiated students, like "all in all you're just another brick in the wall".

It is European Commission statement that properly integrated ICT has enormous potential to contribute to schools' success in facing such complex challenges, but there are certain key conditions to be met:

- students' access to operational infrastructure in the classroom;
- teachers' competences enabling them to use ICT for teaching and learning;
- developed pedagogical environments for ICT;
- available quality learning resources and
- updated students' assessment models.

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According to UNESCO's Framework it is not enough for teachers to have ICT competencies and be able to transfer them to their students but also to be able to help the students become collaborative, problem solving, creative learners through using ICT. The UNESCO Framework is arranged in three different successive stages of a teacher's development:

- Technology Literacy (enabling students to use ICT in order to learn more efficiently);
- Knowledge Deepening (enabling students to acquire in-depth knowledge of their school subjects and apply it to complex, real-world problems), and
- Knowledge Creation (enabling students to create the new knowledge).

Based on case studies done in OECD countries, with the aim to better understand how ICT relates to educational innovation, Venezky and Davis (2002) introduced a 'battery' of factors recognized as crucial ones in successful integration of ICT in education/schools. Their case studies reveal that within the OECD countries there are two far-reaching changes occurring in K-12 schooling. First, a variety of instructional reforms are underway, driven by a perceived need to reorient schooling from rote learning, shallow but wide coverage, and individualistic learning processes to higher level skills, problem solving, in depth study, and collaborative learning. Every OECD country is working to install networks in schools, connect them to the Internet, and ensure a workable configuration of multimedia computers, educational software, technical support, and ICT-savvy teachers.

Venezky and Davis (2002) claim that both infrastructure and teacher competencies are required for successful implementation of ICT in a school. The balance of these two factors, above a critical level of infrastructure, depends upon the school context: how ICT is used and the amount of technical support available to teachers. In addition, during the initial stages of implementing ICT in a school, a reliable and userfriendly infrastructure is critical. As teachers become more technically

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competent, than their general pedagogical abilities and their ability to integrate ICT into the curriculum become more important.

Within any school, acquisition of ICT skills by the teaching staff may not lead to deployment of these skills for teaching. However, sufficient professional development opportunities and support, compensated time off for training, and an adequate ICT infrastructure present the optimal conditions for advancing the adoption of ICT by a school staff. Teachers need time and support to experiment with various scenarios of how ICT can be (best) integrated into their teaching. The most successful staff development programs teach both ICT skills and related pedagogical skills, including how to integrate ICT in teaching.

Although there is no unique successful model of ICT integration into the school system, several crucial factors for efficient implementation were recognized and include: focusing on students and their learning; enpowering the school and its human capital; leadership and coherence; inclusion of relevant parties; follow-up and regular assessment.

1.6. Digitally Mature Schools – The Goal of ICT Integration

The general aim of CARNet's e-Schools pilot project is to make digitally mature schools. Indeed, the full name of the project "e-Schools: Establishing a System for Developing Digitally Mature Schools (pilot project)" indicates the weight that this concept received. Therefore, it seems appropriate to focus on its definition, conceptualization and measurement. Digital maturity can be defined as a concept that describes the extent to which "an organisation uses sophisticated tools to drive performance and demonstrates an on-going commitment to technology, technology-led initiatives and digitally managed processes" (Coleman Parkes Research, 2014). Currently several models of digital maturity exist which are mainly intended for specific type of organizations or sectors (e.g., digital business,

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healthcare, marketing, etc.) They enable organizations to estimate their organizational maturity, by providing comparative standards and guidelines for actions to improve digital competencies and increase the level of organizational digital maturity. Several assessment tools for digital maturity are also available for organizations, e.g. Digital Maturity survey (Deloitte, n.d.) or Digital Maturity assessment (Creative Construction, n.d.). The results obtained in those kinds of surveys help organizations to understand their strengths and weaknesses from a digital perspective. After receiving the results about digital maturity of the organization, consulting services are usually suggested, providing guidelines for digital strategy development and organizational transformation for the future.

In educational sector, several frameworks and self-assessment tools promoting the integration of digital technologies in education are available, usually accompanied by training systems at national/international level (for overview of Frameworks and self-assessment questionnaires see Kampylis, Punie, & Devine, 2015). A large study on digital maturity called 'Digital maturity: The next big step' was conducted in 2014 (Coleman Parkes Research, 2014). The study included respondents from the UK, Ireland, France, Germany, Spain, Italy, Netherlands, Belgium, the Nordics (Sweden, Finland, Norway, and Denmark), Switzerland, Russia, and the Middle East. Respondents were 1,245 business decision makers across eight vertical sectors, including education, legal, utilities/energy, healthcare, public sector, retail, manufacturing and financial services. The results revealed that education was "the most progressive sector in terms of making the transition from a state of digital transformation to digital maturity" (Coleman Parkes Research, 2014). More leaders from the educational sector perceived digital maturity as a key priority (80%) than leaders from other sectors. Educational leaders were also confident that their organizations (mainly schools and universities) could reach digital maturity within two years from the assessment.

In Croatia, digitally mature schools are defined within the e-Schools pilot project as "schools on a high level of integration of ICT in their life and work" (CARNet, 2016a).

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In these schools ICT is systematically used in school management and business processes, as well as in teaching and learning. In order to assess digital maturity of primary and secondary schools in Croatia, a document named Framework for the Digital Maturity of Schools (CARNet, 2016b) has been developed by the Faculty of Organization and Informatics, University of Zagreb, in cooperation with CARNet, as part of the e-Schools pilot project. Based on the Framework for Digital Maturity, instruments for self-evaluation and external evaluation of the digital maturity of schools have been created. The intention is that schools, as well as policy creators and decision-makers, could use the Framework for Digital Maturity as a guide for integration of ICT in learning, teaching, and business activities on the school level, or as a guide for the development of policies and initiatives for the purpose of the successful integration of ICT into the educational system.

The Framework for the Digital Maturity of Schools defines the areas and levels of the digital maturity of schools. Five areas of digital maturity of schools have been proposed according to the Framework: 1) Leadership, planning and management, 2) ICT in learning and teaching, 3) Development of digital competencies, 4) ICT culture, and 5) ICT infrastructure. Each area is consisted of several elements, as noted in the Table 1.

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Table 1. *Areas and Elements of the Digital Maturity of Schools According to the Framework for the Digital Maturity of Schools (CARNet, 2016b)*

Area	Element
Leadership, Planning and Management	▪ Vision, strategic guidelines and objectives of ICT integration ▪ Plan and programme of school development from the perspective of ICT ▪ Managing the integration of ICT in learning and teaching ▪ Managing the integration of ICT in the school's business activities ▪ Managing data collected by means of information systems ▪ Regulated access to ICT resources ▪ Use of ICT in teaching students with special educational needs
ICT in Learning and Teaching	▪ Awareness ▪ Planning ▪ Use ▪ Digital content ▪ Evaluation of students ▪ Students' experience ▪ Special educational needs
Development of Digital Competences	▪ Awareness and participation ▪ Planning ▪ Purpose of professional training ▪ Self-confidence in the use of ICT ▪ Digital competences of students ▪ Special educational needs ▪ Informal learning
ICT Culture	▪ Access to ICT resources by educational staff ▪ Access to ICT resources by students ▪ Network presence ▪ Communication, information and reporting ▪ Netiquette ▪ Copyright and intellectual property ▪ Projects
ICT Resources and Infrastructure	▪ Planning and procurement ▪ Network infrastructure ▪ ICT equipment in the school ▪ ICT equipment for educational staff ▪ Programme tools in schools ▪ Technical support ▪ Equipment maintenance ▪ Central repository of digital documents and educational content ▪ Information security system ▪ Licensing control

The Framework for the Digital Maturity of Schools also defines five levels of digital maturity of schools: 1) Digitally unaware, 2) Digital beginners, 3) Digitally competent, 4) Digitally advanced, and 5) Digitally mature. Digitally unaware schools do not recognize possibilities of using ICT in learning, teaching, and business activities. Educational staff does not develop their digital competencies, on-line

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communication with school is not possible, ICT infrastructure is not provided, and there are only few computers available in such schools. By contrast, digitally mature schools recognize numerous possibilities of ICT use in learning, teaching, and business activities, and they use ICT on daily basis. ICT is incorporated into strategic documents of digitally mature schools, as well as in the school plan and program development. Digitally mature schools foster systematic approach to the development of digital competencies of educational staff and students. Teachers in digitally mature schools use ICT for innovating teaching and for students' performance assessment. They use shared digital repository that is also available to students. Digital content is protected by appropriate licenses. Entire school has a developed network infrastructure. Access to ICT resources is available in all premises and from private devices. An information security system based on best practice has been developed and software licensing is systematically controlled and planned. A mature school is characterized by different ICT activities, there is good cooperation between the staff and the students, as well as between the school and other stakeholders by means of on-line communication tools and the school's e-services.

As mentioned, several frameworks and self-evaluation tools for assessing the degree of integration of ICT in educational organizations are in use in a number of European countries and wider. The Framework for the Digital Maturity of Schools in Croatia was created on the basis of two existing European frameworks: DigCompOrg (Kampyls et al., 2015), the European framework for the digital maturity of educational institutions, and the e-Learning Roadmap tool (NCTE, 2009) which was used in Ireland for the purpose of certifying digitally mature schools.

The e-Learning Roadmap (NCTE, 2009) is a planning tool designed to help schools to identify where are they currently positioned in relation to e-Learning, and where they would like to go. Schools evaluate themselves on a number of elements related to Leadership & planning, ICT & the Curriculum, Professional development, e-Learning Culture, and ICT Infrastructure. Each element is described by four statements describing different levels of digital maturity that are categorised as

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follows: Initial, e-Enabled, e-Confident, and e-Mature. Self-assessment tool is accompanied with Education's e-Learning Handbook that provides a step by step guide for development of the school's e-Learning Plan and delineates the key roles and responsibilities of all involved in the development of the plan.

While The e-Learning Roadmap is developed primarily for the assessment of schools in Ireland, The European Framework for Digitally-Competent Educational Organisations (DigCompOrg) is a European reference framework (authored by Kampylis et al., 2015). It adopts a systemic approach to organisational digital capacity and goes beyond a synthesis of current conceptualizations and practices described in existing frameworks that depict digital maturity in different educational contexts and countries. The DigCompOrg Framework is aimed at facilitating transparency and comparability between related projects throughout Europe. It "can be used by educational organisations (i.e., primary, secondary and VET schools, as well as higher education institutions) to guide a process of self-reflection on their progress towards comprehensive integration and effective deployment of digital learning technologies" (Kampylis et al., 2015, p. 4). DigCompOrg focuses mainly on the teaching, learning, assessment and related activities that educational organisations carry out. It can also be used by policymakers as strategic planning tool to encourage policies for the successful integration of digital learning technologies by educational organisations at different levels (regional, national and European).

The DigCompOrg framework includes seven key elements and fifteen sub-elements that are common to all education sectors. In addition to these cross-sector elements (and sub-elements), DigCompOrg is open to the addition of sector specific elements. Sub-elements are further described by 74 descriptors. Seven cross-sector elements as defined in DigCompOrg are: Leadership and governance practices, Teaching and learning practices, Professional development, Assessment practices, Content and curricula, Collaboration and networking, and Sector-specific element(s).

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In-depth analysis and comparison of 15 existing frameworks and self-assessment questionnaires (including the e-Learning Roadmap tool) that preceded the development of The DigCompOrg framework was based on the concept of Creative Classrooms (CCR). "Creative Classrooms are conceptualised as innovative learning environments that fully embed the potential of ICT to innovate and modernise learning and teaching practices" (Bocconi, Kampylis, & Punie, 2012, p. 7). The term 'creative' refers to fostering creative learning through technologies, but also encompasses other innovative practices, including collaboration, personalisation, active learning and entrepreneurship; while the term 'classrooms' refers to different types of learning environments, in formal and informal settings.

Multi-dimensional CCR concept consists of eight key dimensions (Content and curricula, Assessment, Learning practices, Teaching practices, Organization, Leadership and values, Connectedness and Infrastructure), and 28 reference parameters (building blocks) that capture the essential elements of Creative Classrooms. In CCR, "curriculum and content are open, providing learners with concrete opportunities for developing 21st century skills, such as problem-solving, inquiry, collaboration, and communication. Learning is flexible and engaging, meeting students' individual needs and expectations. Leadership is open and participatory, supporting teachers'/educators' innovative practices. E-Assessment paradigm now reflects the core competences needed for life in the 21st century" (Bocconi et al., 2012, p. 7).

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2. FACTORS THAT INFLUENCE ICT IMPLEMENTATION

Although there is almost a general consensus that ICT skills are extremely important in modern education, and that the potential ICT has for improving educational process is substantial, implementation in the educational system is far from easy. Relevant literature is abundant with different obstacles which may hinder ICT adoption and integration. On the other, more optimistic, hand, there are also conditions which facilitate this process. We have tried to find as many of these as possible and list them in a systematic and meaningful way. Although these elements are usually called barriers and enablers, respectively, both of them can be conceptualized as variants of basically, or conceptually, the same factor. Following this reasoning, we have not used the categorization based on 'barriers' and 'enablers'. Rather, we tried to map as many relevant *factors* from the literature, which can be seen as variables, i.e. they can vary from being detrimental to being beneficial for ICT adoption, integration and use. This review of factors which influence implementation of ICT in education is not conclusive or all-inclusive. The references included in this report possibly ignored or overlooked some important papers and reports, and, consequently, some potential additional factors. However, the authors believe that they have gathered more than a critical amount of references and covered the most essential variables.

In this context, it is also important to note that, according to Hutchinson and Reinking (2011), there is little consensus on the factors that may present obstacles to successful integration of ICT in education. Although different methods have been used (i.e., qualitative, quantitative and mixed), the consistency of the results is limited. Therefore, even if all possible studies relevant to the topic of barriers or enablers to ICT adoption and integration were included, there would be a real possibility that in other samples, using different measures, at different points in time, different factors would emerge as significant.

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In the following overview, we tried to include all factors which might affect the integration of ICT in education, ignoring their valence in the original source (i.e., barriers or enablers). Following several previous authors (Balanskat, Blamire, & Kefala, 2006; Bingimlas, 2009; Jones, 2004) we divided these factors into three categories – teacher-level factors, school-level, and system-level factors. In other words, we divided the factors whether they were characteristics of teachers, schools, or school systems, respectively. Some of them are consistent across different studies, groups and subjects, and some are more specific in terms of generalizability.

2.1. Teacher-Level Factors

2.1.1. Digital Competencies

In the recent years numerous contributions were directed toward defining "digital competence" as an important requisite for digital era. Moreover, due to the advancements in the availability of technology, the operationalisations of digital competence have changed over time (Siddiq, Hatlevik, Olsen, Throndsen, & Scherer, 2016). In an integrative literature review on digital competence and related terms, Gallardo-Echenique, de Oliveira, Marqués-Molias and Esteve-Mon (2015) identified extensive literary diversity surrounding this concept, as well as a variety of its theoretical interpretations (e.g., Digital Literacy, Digital Competence, eLiteracy, e-Skills, eCompetence, Computer literacy, and Media literacy). Digital competence has been viewed as both, the technical use of ICT and more broadly as the knowledge application or as 21st century skills. On the basis of this literature review, digital competence were delineated as multi-faceted concept that still lacks clear assessment guidelines.

Digital competence was defined by the European Parliament and the Council of the European Union as: "the confident and critical use of information Society technology (IST) for work, leisure, learning and communication. It is underpinned by basic skills in ICT: the use of computers to retrieve, access, store, produce, present and exchange

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information, and to communicate and participate in collaborative networks via the Internet" (p. 13).

Furthermore, in an attempt to synthesize existing frameworks of digital competence as a 21st century skill and thereby to propose specific descriptions and dimensions of the construct, the Joint Research Centre Institute for Prospective Technological Studies (JRC-IPTS) launched a project that resulted in a comprehensive and yet flexible framework - DigComp. In this context, Ferrari (2012) defined digital competence as "the set of knowledge, skills, attitudes, abilities, strategies, and awareness that are required when using ICT and digital media to perform tasks; solve problems; communicate; manage information; collaborate; create and share content; and build knowledge effectively, efficiently, appropriately, critically, creatively, autonomously, flexibly, ethically, reflectively for work, leisure, participation, learning, and socialising" (p. 30).

Despite the fact that digital competence shares some similarities with closely related concept of digital literacy, the two of them are not identical (Gallardo-Echenique et al., 2016). Digital literacy has a longer tradition and reflects a combination of technical-procedural, cognitive, and emotional-social skills. In this regard, two main approaches to these constructs were highlighted: digital competence at the convergence of multiple literacies and digital competence as a new literacy involving new components and a high degree of complexity (Ferrari, Punie, & Redecker, 2012).

The DigComp – A Framework for Developing and Understanding Digital Competence in Europe (Ferrari, 2013) is based on a review of 15 digital competence frameworks including: (a) a conceptual mapping of digital competence (Ala-Mutka, 2011), (b) an analysis of case studies of several digital competence frameworks (Ferrari, 2012), and (c) a Delphi study investigating the opinions on what it means to be digitally competent expressed by relevant stakeholders and experts (Janssen et al., 2013).

The DigComp framework establishes five areas of digital competence: Information, Communication, Content creation, Safety, and Problem solving. Each of these five

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areas further contains the particular competences. The third level formulates a discrete number of proficiency levels for each competence, while the fourth level outlines examples of knowledge, skills, and attitudes applicable to each competence. The last and fifth level displays a contextual elaboration by providing examples of the applicability of the competence for different purposes. In this vein, the DigComp framework represents one of the most recent and extensive frameworks which attempts to outline what digital competence is and which specific aspects it includes.

As a conceptual framework, the DigComp aimed to be a start in conceptions and interpretations of digital competence and social practices using digital media, which over time will have to become more elaborated and specified. Also, in order to be implemented, the competences are ment to be adapted to the particular needs of a specific target group. The level of abstraction of the competences that are foreseen in the framework allows stakeholders to refine and specify sub-competences in the terms they consider most appropriate for the target groups or context (Ferrari, 2013). In the area of teachers' digital competence, there are several national (e.g., Norway, Slovenia) and international (e.g., UNESCO, ISTE) competence frameworks, each with their own underlying logic, specificity and level of development.

In Croatia, the DigComp framework was recently adapted and upgraded according to the specific characteristics and needs of particular beneficiary groups in schools and of the educational system of the Republic of Croatia. Specifically, the Croatian Framework for the Digital Competence of Beneficiaries in School including the teachers (Žuvić, Brečko, Krelja Kurelović, Galošević, & Pintarić, 2016) was developed.

The Framework for the Digital Competence describes sets of competencies required to perform certain activities in school, by using digital technology and resources. In this regard, the Framework connects sets of competences to job activities of target user groups in school: teachers, professional staff, headmasters and administrative staff.

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Digital competencies described in the Framework are considered within three dimensions: 1. General digital competencies, 2. Competences for the application of digital technology in education, and 3. Digital competencies for school management. For educational staff general digital competencies and competences for the application of digital technology in education pertain, while for the headmasters general digital competencies and digital competencies for school management are relevant.

General digital competencies in the Croatian Framework for the Digital Competence of Thearchers are aligned with European Framework "DigComp 2.0: The Digital Competence Framework for Citizens" (Vuorikari, Punie, Carretero Gomez, & Van den Brande, 2016). DigComp is a document that is "aimed to be a tool to improve citizens' digital competence, to help policy-makers to formulate policies that support digital competence building, and to plan education and training initiatives to improve digital competence of specific target groups" (Vuorikari et al., 2016, p. 5).

Competences for the application of digital technology in education were developed based on UNESCO ICT Competency Framework for Teachers (Hine, 2011), IT competency Framework for Teacher (Kennisnet, 2012), and E-šolstvo: Ishodišča standarda e-kompetentni učitelj, ravnatelj in računalnikar (Kreuh & Brečko, 2011).

Each of the dimensions of digital competence in the Framework for Digital Competencies is described in several areas. Within each area sets of competencies are defined and elaborated by several elements of competence. Finally, each of the elements of competence is elaborated at three levels of complexity - foundation, intermediate and advanced. A Framework for the Digital Competence of Teachers in Croatia is presented in Table 2.

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Table 2. *Croatian Framework for the Digital Competence of Teachers (Žuvić et al., 2016)*

Dimension	Area	Competence
General Digital Competencies	O1. Information and Data Literacy	O1.1. Examining, browsing, searching and filtering data, information and digital content.
		O1.2. Evaluating data, information and digital content.
		O1.3. Managing data, information and digital content.
	O2. Communication and Collaboration	O2.1. Interacting through digital technologies.
		O2.2. Sharing through digital technologies.
		O2.3. Engaging in citizenship through digital technologies.
		O2.4. Collaborating through digital technologies.
		O2.5. Netiquette (respecting behavioural norms in digital environments).
		O2.6. Managing digital identity.
	O3. Digital Content Creation	O3.1. Developing digital content.
		O3.2. Integrating and re-elaborating digital content.
		O3.3. Copyright and licences.
		O3.4. Programming.
	O4. Safety	O4.1. Protecting devices.
		O4.2. Protecting personal data and privacy.
		O4.3. Protecting health and well-being.
		O4.4. Protecting the environment.
	O5. Problem Solving	O5.1. Solving technical problems.
		O5.2. Identifying needs and technological responses.
		O5.3. Creatively using digital technologies.
		O5.4. Identifying digital competence gaps.
Competences for the Application of Digital Technology in Education	P1. Using Digital Technologies in Teaching and Learning	P1.1. Including digital technologies in curriculum planning.
		P1.2. Using digital technologies in teaching.
		P1.3. Appling digital educational content and learning scenarios in the teaching process.
		P1.4. Creating digital educational content and learning scenarios in the teaching process.
		P1.5. Designing environment for active learning and knowledge construction by using digital technology.
		P1.6. Using digital technology for monitoring and assessing students.
	P2. Working in the School Environment	P2.1. Using digital technology for classroom management.
		P2.2. Keeping pedagogical documentation in digital format.
		P2.3. Collaborating with students, teachers and parents in the digital environment.
	P3. Professional Education and Lifelong Learning	P3.1. Learning by means of digital technology and learning about the use of digital technology in the classroom.
		P3.2. Exchanging knowledge and experience about subject area and teaching practices in a virtual environment.

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Teachers digital competences are viewed as a key factor that enables teachers to change their educational practice and to implement technologies in their educational practice (Ertmer & Ottenbreit-Leftwich, 2010). Therefore, besides the DigComp proposal adaptations for teachers, several other models of competence in ICT have been proposed in recent years for teachers, e.g. those developed by the International Society for Technology in Education [ISTE] (2008), UNESCO (Hine, 2011) and the Technological Pedagogical Content Knowledge (TPACK) (Mishra, Koehler, & Kereluik, 2009). Given that each of these models has its own dimensions, there is a lack of explicit agreement about defining a common competence framework (Hall, Atkins, & Fraser, 2014). Nonetheless, the technological competences and pedagogical competences are the two large subsets that can be explicitly identified within different ICT competence frameworks for teachers. It has been suggested that the pedagogical competences are influenced by the technological ones (Ertmer & Ottenbreit-Leftwich, 2010). This means that although technological competences do not suffice to integrate ICT into classrooms, they are actually required for the development of teachers pedagogical competences.

Recently, Almerich, Orellana, Suárez-Rodríguez, and Díaz-García (2016) validated a basic ICT competences model as a common model for all teachers at all levels of education (primary, secondary and tertiary). The model comprises technological and pedagogical competences as two subsets of a unique set of teachers' ICT competences. Technological competences include knowledge and skills which enable teachers to master technological resources needed for their teaching practice, while pedagogical competences refer to knowledge and skills which allow theachers the employment of technological resources in curricular designs and in planning of their teaching. The results indicated that technological competences act as the antecedents required to develop pedagogical competences constituting the basis of the pedagogical competences. Therefore, teachers have to master technological competences first in order to implement the pedagogical competences.

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Several authors (e.g., Bingimlas, 2009; Jones, 2004) have suggested that teachers' adoption and integration of ICT is dependent on their skills and competences in using those resources. For example, some studies have shown that teachers choose not to use ICT in teaching because they lack the skills, and not because it makes sense in the context of appropriate teaching approach (Balanskat et al., 2006). Similarly, based on previous studies, Buabeng-Andoh (2012) concluded that ICT competence is one of the major predictors of ICT adoption, that is, that individuals which reject ICT in education system usually do not have sufficient knowledge and skills to make an informed decision. Balanskat et al. (2006) suggest that this effect is mediated by motivation and confidence in using ICT, that is, low ICT skills lower the motivation for ICT use in teaching and confidence in using technology, which leads to low actual use (see the section 'Confidence in using ICT/Computer self-efficacy'). Naturally, if teachers do not have appropriate skills for using technology, and if they are somewhat self-aware of their competencies, they will not be confident about integrating these new tools into their teaching. Consequently, their motivation to use and actual use of ICT in lessons will decrease. These results and findings of different studies are quite intuitive and may seem as rational human behavior. In other words, teachers who do not possess adequate knowledge, skills, and attitudes (i.e., competencies) to successfully use new technologies in class, act reasonable when they choose traditional teaching methods instead of ICT. However, this also implies that one of the priorities in efforts to implement ICT into education is to provide teachers with appropriate education in order to gain at least minimal levels of digital competencies. Although professional development programs should offer more than just ICT skills training (see also section 'Appropriateness of teacher training'), educating teachers, who are the foundation of ICT integration in schools, and turning them into competent technology users is likely to have multiple effects. That is, positive change in teachers' digital competencies will also motivate them to put their newly-acquired skills into practice and reduce anxiety and fear of failure (see also next section 'Confidence in using ICT/Computer self-efficacy') which are important barriers to ICT use, especially with 'digital natives' (Prensky, 2001) which

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are perceived as superior technology users in comparison with their teachers. In conclusion, one of the most important ways to influence the level of ICT use, adoption and integration by teachers is to teach them "how". It is, however, important to keep in mind that this is only one 'piece of a puzzle'.

European Commission's (2013) large-scale study Survey of Schools: ICT in Education showed that teachers' self-reported digital competencies[1] influence the frequency with which teachers use ICT-based activities in the classroom. A positive correlation was found between teachers' self-reported level of skills in operational use of ICT and their social media and the frequency with which they use ICT-based activities across all grades. The results indicate that students taught by teachers who reported higher levels of ICT competence and were positive about ICT use in teaching and learning, but faced low access and high obstacles to use it at school, reported more frequent use of ICT during lessons compared to students taught by teachers having high access and facing few obstacles, but reported lower levels of ICT competence and were not positive about ICT use for teaching and learning. So, the higher the teachers assess their own digital competencies, the more they use ICT-based learning activities during lessons. It is important to point out that once again, human factor was shown to be more important than mere existence of technology. In other words, it is better to concentrate the attention to teachers in order to make them well-equipped for using the ICT infrastructure in best possible way.

The Survey (European Commission, 2013) also provides information on the current state of teachers' self-reported digital competencies, both in EU countries, and, comparatively, in Croatia (European Commission, 2012). The results are indicative for the above mentioned importance of focusing on teachers. Namely, across the EU countries covered by The Survey, on average between 20-25% of students are taught

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[1] In the Survey, teachers' confidence in their ICT skills was used as a measure of their sefl-reported digital competence. However, we believe that it is in fact a measure of digital competencies based on self-assessment.

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by digitally competent and supportive teachers[2] having high access to ICT and facing low obstacles to their use at school. In Croatia, percentages of students taught by digitally supportive teachers are consistently below EU average. Croatia is ranked among the lowest group of countries at all grades when it comes to students taught by digitally supportive teachers. The mean score of students being taught by teachers declaring competence in operational and social media skills is in all grades below 3 (with 1 being 'none' and 4 being 'a lot'), substantially lower than the EU average. When comparing teacher competence in operational skills at grade 8, Croatia is placed last among countries surveyed. Also, regarding teachers' competence in social media skills, Croatia is also in the bottom group of countries, except for vocational secondary schools, in which case it is in the middle group of countries.

Our previous research which was conducted as a part of the first phase of this project [e-Schools: Establishing a System for Developing Digitally Mature Schools (pilot project)] (Center for Applied Psychology, 2015b) included self-assessment of teachers' digital competencies. The results showed that teaching experience is strongly related to self-reported digital competencies. Namely, less experienced teachers had higher scores in both total level, and specific dimension level (responsible and safe Internet use, skills for social media use (communication), operational skills (creating content), and problem solving) of digital competencies. This finding is also interesting and relevant in terms of the relationship between teachers' experience and level of ICT use (see section 'Teaching experience'; Pahljina-Reinić, Smojver-Ažić, Martinac Dorčić, Sušanj, & Miletić, 2016), for it might be partially mediated by digital competencies. The results also indicated that digital

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[2] Teachers which evaluated highly their ICT operational and social media skills and ability to use the Internet safely and responsibly, having positive opinions about ICT use for teaching and learning, as well as facing low obstacles and having high access to ICT infrastructure at school (European Commission, 2013).

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competencies are related to ICT use in schools (Center for Applied Psychology, 2015b).

As previously mentioned, a construct closely related to digital competencies is digital literacy. Mohammadyari and Singh (2015) claim that digital literacy has an important role in realizing the potential of having access to technology. That is, in line with findings from literature, they summarize the necessary skills for optimal and effective use of IT. These skills include socio-emotional, cognitive, and technical skills (Mohammadyari & Singh, 2015), such as ability to operate different types of technical resources, to "search, find, and evaluate information effectively for learning purposes" (Mohammadyari & Singh, 2015, p. 14), behave appropriately in digital communities, and ability to protect oneself in digital environments. The authors reported on the role of digital literacy in the acceptance of e-learning. In their study on accountants, digital literacy affected intentions to continue using Web 2.0 tools and, consequently, on performance, through effort and performance expectancy. In other words, individuals with higher levels of digital literacy believed that their usage of a particular technological tool will be easy, and that it will have positive effects on their performance. Furthermore, their expectancy that usage will ameliorate performance (performance expectancy), will lead to intention to continue using the tool, which actually improves performance. Digital literacy also predicts effort expectancy (the extent to which users believe that using an application is free of effort). However, this variable is unrelated to intention or performance. So, digital literacy is not only conceptually similar to digital competencies, but has the same empirical relations with the level of ICT use, adoption, and integration.

Factor closely related to teachers' level of digital competencies is their confidence in using ICT. Some authors refer to 'computer self-efficacy'. Although these constructs are distinct, generally in psychology, and specifically in ICT literature, we merged them into one category due to their conceptual similarity and their empirical effect on the level of ICT integration.

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2.1.2. Confidence in Using ICT/Computer Self-Efficacy

A number of authors emphasize the importance of teachers' confidence in using ICT (e.g., Balanskat et al., 2006), or in similar vein, of their levels of computer self-efficacy[3] (e.g., Buabeng-Andoh, 2012). The basic idea is simple; teachers' self-assessed ability to successfully integrate ICT into their lessons will determine their actual adoption, integration, and use of technology. Parallel to the relationship between digital competencies and ICT use, the correlation with confidence or self-efficacy may even be stronger. What is more, the predictive power of ICT skills for ICT use may partially be attributable to self-evaluated skills which furthermore affect confidence in ICT use levels. In other words, teachers with lower levels of digital competence will probably recognize this lack of abilities, which will make them less confident and less likely to use technology in classrooms.

Our results from previous study (Center for Applied Psychology, 2015b) showed that teachers from 20 schools selected for the Pilot study evaluated their self-efficacy for ICT use quite positively. Less teaching experience was positively related to self-efficacy scores, and similarly to digital competencies, self-efficacy might be a mediator between experience and ICT use (see section 'Teaching experience'). There are also significant differences between subject type. Namely, teachers that teach STEM subjects are higher on self-efficacy for ICT use than the ones who teach languages, social sciences, and humanities. Importantly, self-efficacy is related to perceived advantages and disadvantages of ICT use. More specifically, teachers with higher self-efficacy levels perceived more benefits and less risks. Furthermore, when predicting the frequency of ICT use in teaching, the strongest predictor was precisely teachers' self-efficacy (Pahljina-Reinić et al., 2016).

Therefore, in order for any project which aims to increase ICT use in educational system to be successful, much effort will have to be invested in teachers as main

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[3] In this specific context, computer self-efficacy refers to teachers' perceptions that they have the ability to successfully integrate ICT into their lessons (Buabeng-Andoh, 2012).

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agents of ICT implementation. That is, besides investing in ICT infrastructure, which is a necessary condition for successful integration (see also section 'ICT infrastructure'), it is absolutely fundamental to influence teachers' digital competencies and, importantly, their confidence in using ICT or computer self-efficacy. For teachers to feel motivated and excited about potential advancement of their lessons using technology, they have to feel that they are able to use it efficiently. The best way for them to perceive that they have the ability to successfully use technology is to actually have this ability.

2.1.3. Teachers' Perceptions, Beliefs, and Attitudes

Additional factors that are considered to be important in the context of ICT adoption and integration by most experts are teachers' perceptions, beliefs, and attitudes (Buabeng-Andoh, 2012; Ertmer, 2005; Hutchinson & Reinking, 2011; Teo, 2011). Quite intuitively, if teachers have shallow definitions, incomplete perceptions of ICT integration, or completely negative beliefs towards technology, they will most likely not use it, or they will use it inappropriately (Hutchinson & Reinking, 2011).

When it comes to teachers' perceptions, it is quite useful to take advantage of two important models. The first one is Rogers' model (1962/2003) of diffusion of innovation. Although his primary focus is on the five groups of people who vary in their openness to innovation (see 'Introduction'), Rogers also listed five characteristics of the innovation itself which affect the likeliness of its adoption. According to Rogers, these characteristics explain 49% to 87% of variance in innovation adoption:

a. Relative Advantage to the Idea Preceding IT

Relative advantage represents the degree to which an innovation is perceived as better than the current standard. The criteria for the comparison between the 'old' and 'new' are determined by the population of potential adopters, that is, they are compared in the variables that a certain societal system holds

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valuable. Naturally, if the innovation is perceived to be better than the old standard according to these criteria, it is more likely that it will be adopted.

b. Compatibility with Needs and Values

This characteristic refers to the similarity of innovation and the existing values, needs, and experiences of a particular system. The more consistent the innovation is with the current values and needs, the more likely it is to be adopted. Therefore, in order for a certain innovation to be integrated in a system, it has to be perceived as a tool that will fulfill the needs of the members of the system and that is in line with their values. Innovations which fail to meet these requirements are not likely to be adopted.

c. Complexity

If an innovation is perceived as easily understood and applied, it is likely to be adopted. On the other hand, if it is perceived as complicated, and that it requires new knowledge and skills, it will not be that easily adopted. Human beings have the tendency to save energy and not to put effort into an action if they do not have to. However, there are situations in which people neglect cues that indicate heightened effort requirements (see the section on Technology Acceptance Model; Davis, Bagozzi, & Warshaw, 1989).

d. Trialability

Innovations which could be tested on a smaller scale are more likely to be adopted, because they pose less risk for potential adopters. If the members of the system get a chance to do a 'pilot adoption' of an innovation, they will feel more secure and certain in their decision to accept it on a full scale because they already have their own, authentic experience.

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e. Observability of Results

This characteristic of innovation encourages the users and acts as a motivator. Quick improvements lower the level of uncertainty, stimulate peer discussion and enhance the potential of the innovation. Of course, visible results are a good motivation, but they also confirm that the decision to adopt the innovation was not a (potentially) costly mistake.

The second model is the Technology Acceptance Model (TAM; Davis et al., 1989), one of the most influential and well-studied models of technology integration. For example, a meta-analysis of Technology Acceptance Model included 88 relevant studies (King & He, 2006). This model defines two factors that predict attitude toward innovation, which consequently affects intention to use and, finally, actual use of technology. These factors refer to perceived usefulness and perceived ease of use, that is, the degree to which a potential user perceived that the technology use will have some positive results, and the degree to which a potential user perceives that it will be easy to operate, respectively. More specifically, according to the model, the main determinants of technology use (by means of attitude toward using and behavioral intention to use) are the levels at which potential users perceive that it will be beneficial and easy. These variables (i.e., perceived usefulness and perceived ease of use) have a mediating role between external characteristics (e.g., system characteristics, implementation process, training) and behavioral intention. Also, the model states that perceived usefulness is affected by perceived ease of use. Namely, the logic is the following: the easier the system is to use, the more useful it will be. Furthermore, the model specifies that even if the potential users perceive the innovation as difficult to use, if the perceived benefits outweigh the perceived ease of use, adoption is more likely (Figure 5). A meta-analytic study by King and He (2006) showed that this model is quite robust, and that indeed, "influence of perceived usefulness on behavioral intention is profound" (King & He, 2006, p. 751). In other words, as predicted by the original model, perceived usefulness has more

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weight than perceived ease of use, which realizes it's effects on behavioral intention through perceived usefulness.

Figure 5. *Technology Acceptance Model (Davis et al., 1989)*
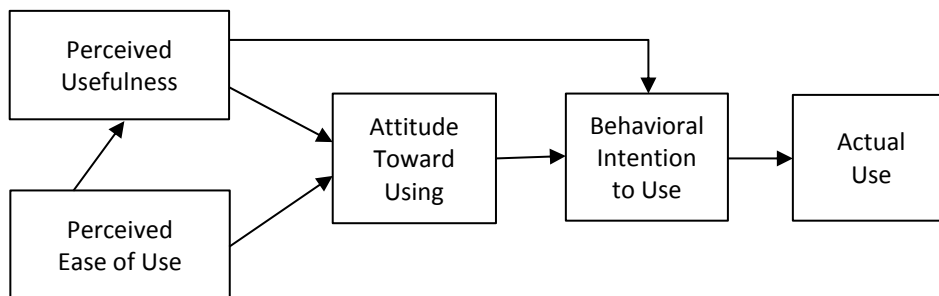
Furthermore, Venkatesh and Davis (2000) conducted a longitudinal study with the goal of extending Technology Acceptance Model (Davis et al., 1989) with additional factors which would represent determinants of perceived usefulness and usage intention. Also, they wanted to test the change of these effects in function of time which is related to increase in user experience with the technology being implemented. This extended model is referred to as TAM2. The proposed model (see Figure 6) included constructs covering social influence processes and cognitive instrumental processes.

a. Social Influence Processes

Similar to Rogers' model (1962/2003), TAM2 emphasizes the importance of the fact that innovation adoption is always immersed into a social context. In other words, the decision about accepting or rejecting a technological innovation is not dependent solely on the (perceived) characteristics of the innovation and its effects. New technology is also evaluated in terms of its 'popularity' in the minds of relevant members of a working collective. TAM2 adds several social variables which might affect the level or behavioral intention to use technology directly and indirectly through perceived usefulness. These factors include subjective norm, voluntariness and

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compliance with social influence, internalization of social influence, and social image.

i. Subjective Norm

Subjective norm refers to "a person's perception that most people who are important to him think he should or should not perform the behavior in question" (Fishbein & Ajzen, 1975, p. 302). It is assumed that subjective norm has a direct effect on behavioral intention because people may intend to engage in an activity despite their perception that it is not useful (i.e., perception of usefulness), and due to their perception that one or more of their 'important others' believe that they should.

ii. Voluntariness and Compliance with Social Influence

Voluntariness, meaning the level to which it is perceived that the adoption decision is non-mandatory, is a moderating variable in TAM2. Specifically, the model states that the direct effect of subjective norm over and above of the effects of perceived usefulness and perceived ease of use will be significant in mandatory, but not voluntary usage environments.

iii. Internalization of Social Influence

TAM2 proposes an additional path through which social norm influences behavioral intention indirectly. In other words, social norm affects behavioral intention through perceived usefulness. More specifically, if a person perceives that an important referent believes he/she should use the innovation, by means of a process called *internalization*, the person will accept this belief as one's own. The perceived belief of an important referent will be regarded as informational about the innovation itself, which will affect the level of perceived usefulness and, consequently, behavioral intention.

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iv. Image and Social Influence

Another indirect way in which subjective norm can influence behavioral intention is through process of *identification*. That is, a person can increase its group status or image by adhering to group norms. In working collectives, this heightened status and social support may often be a prerequisite for successful realization of tasks. In line with this, within the TAM2, it is expected that perception of subjective norm for innovation use within the group will lead to perception that it will alleviate productivity (i.e., perceived usefulness) via increased image, which will, consequently, increase behavioral intention. More specifically, if a person perceives that there is group expectation for innovation adoption, they will believe that innovation use will increase their productivity not because of the characteristics of the innovation, but because it will positively affect their status (i.e., image) in their group. As previously stated, status is an important determinant of productivity because in working environments employees are usually interdependent.

v. Changes in Social Influence with Experience

TAM2 states that some effects of subjective norms will be stable over time, while some will be diminished. For example, it is assumed that direct effects of subjective norms on behavioral intentions in mandatory usage environments will be strong before implementation and in the early stages of use. However, these effects are likely to weaken in time, when straightforward experience with the innovation provides the grounds for intentions to continue using the innovation. In line with that, it is expected that the indirect effect of subjective norm on perceived usefulness by means of internalization process will also weaken with time. Namely, direct experience with the innovation will provide the necessary information for intentions to use it, while informational influence of other

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group members becomes needless. However, indirect effect of subjective norm through the process of identification is not likely to decrease over time. Namely, as long as group norms imply the usage of the innovation, the perceived gains of accepting the norm will continue to contribute to perceived usefulness.

b. Cognitive Instrumental Processes

Venkatesh and Davis (2000) argued that "people form perceived usefulness judgments in part by cognitively comparing what a system is capable of doing with what they need to get their job done" (p. 190). They used theoretical constructs from several areas (i.e., work motivation theory, Vroom, 1964; action theory from social psychology, Fishbein & Ajzen, 1975; task-contingent decision making from behavioral decision theory, Beach & Mitchell, 1978) as cognitive determinants of perceived usefulness. These approaches share a common assumption; an incentive for engaging in a certain behavior comes from a mental representation which associates this behavior to higher-level goals. In other words – is this behavior (in this case, ICT use) important for my work goals? The selected cognitive determinants of perceived usefulness include job relevance, output quality, result demonstrability, and an original TAM construct, perceived ease of use.

i. Job Relevance

Job relevance is a construct that refers to "the degree to which the target system is applicable to [a potential user's] job. In other words, job relevance is a function of the importance within one's job of the set of tasks the system is capable of supporting" (Venkatesh & Davis, 2000, p. 191). Job relevance is expected to have a direct effect on perceived usefulness and therefore indirectly have an effect on behavioral intention. Namely, the more a system (i.e., technological innovation) is perceived as

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relevant for performance tasks or higher-level goals, the more it will be perceived as useful.

ii. Output Quality

Besides their judgments of task relevance, the TAM2 states that perception of output quality is an important determinant of perceived usefulness. Specifically, output quality refers to the extent to which the system at hand performs the relevant tasks well. In other words, the potential users need to perceive that a system not only fits to important goals, but also that its use leads to wanted outcomes. It is assumed that the perception of output quality will positively predict perceived usefulness.

iii. Result Demonstrability

An important determinant of perceived usefulness is result demonstrability. Namely, the authors emphasize that it is crucial for potential users to attribute benefits and gains to the system, and not something else. Even if a system is perceived as job relevant and with potential positive outcomes, if the relationship between system use and results is not clear, it will not be perceived as useful.

iv. Perceived Ease of Use

The TAM2 retained the original TAM element perceived ease of use. This factor affects behavioral intention both directly and indirectly through perceived usefulness ("all else being equal, the less effortful a system is to use, the more using it can increase job performance", Venkatesh & Davis, 2000, p. 192).

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v.   Changes in Cognitive Instrumental Influences with Experience

TAM2 does not posit any changes in the effects of cognitive determinants on perceived usefulness at different points in time. That is, they expect that people will continuously rely on previously explained perceptions and judgments for their ongoing usefulness perceptions.

Figure 6. *TAM2 – Extension of the Technology Acceptance Model (Venkatesh & Davis, 2000)*
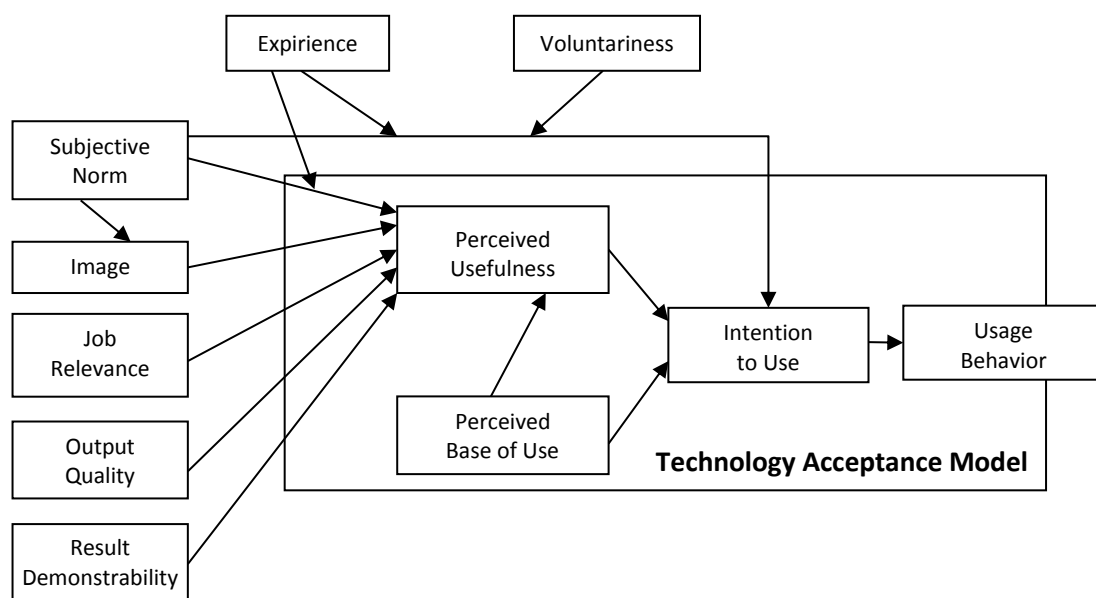
Venkatesh and Davis' (2000) longitudinal study included four work organizations and was conducted at three points in time: after initial training, one month after implementation, and three months after the implementation. Additional usage measure was also taken in the fourth point, five months after implementation. Their findings are completely in line with the proposed model. Namely, as expected, perceived usefulness and perceived ease of use were significant and consistent predictors of behavioral intention (which fully mediated all effects on usage behavior, including the subjective norm effect) at all time points. Subjective norm, on the other hand, as predicted, had no direct effect on intention in voluntary context. In mandatory context, subjective norm determined behavioral intention only in the first phases of implementation. Effect of subjective norm on perceived

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usefulness in all contexts (indicating process of internalization) also diminished by the third measurement point. Furthermore, effect of subjective norm on image was significant across all time points. Also, all cognitive variables (job relevance, outcome quality, result demonstrability, and perceived ease of use) were significant predictors of perceived usefulness, as predicted. TAM2 proved to be an important expansion of TAM, especially in terms of detecting the determinants of perceived usefulness. Namely, the model explained up to 60% of "this important driver of usage intentions" (Venkatesh & Davis, 2000, p. 198). Furthermore, it is important to emphasize the distinct effects of mandatory versus voluntary implementation. It is obvious from the results that voluntary-based approaches are more effective over time.

In 2003, Venkatesh, Morris, Davis, and Davis tested eight models which are related to technology acceptance against each other. These included Theory of Reasoned Action (Fishbein & Ajzen, 1975), Technology Acceptance Model (TAM and TAM2) (Davis et al., 1989; Venkatesh & Davis, 2000), (applied) Motivational Model (Davis, Bagozzi, & Warshaw, 1992), (applied) Theory of Planned Behavior (e.g. Taylor & Todd, 1995b), Combined Technology Acceptance Model and Theory of Planned Behavior (Taylor & Todd, 1995a), Model of PC Utilization (Thompson, Higgins, & Howell, 1991), (adapted) Innovation Diffusion Theory (Moore & Benbasat, 1991), and (adapted) Social Cognitive Theory (Compeau & Higgins, 1995). Furthermore, the authors merged constructs that proved to be significant into a Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh et al., 2003). Concepts from different models which were conceptually equivalent, or very similar were merged into one category. The proposed model is shown in Figure 7.

a. Performance Expectancy

Performance expectancy refers to "the degree to which an individual believes that using the system will help him or her to attain gains in job performance" (Venkatesh et al., 2003, p. 447). This single construct includes five variables

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from different models (e.g., perceived usefulness from TAM/TAM2) and is the strongest predictor of usage intention. The effect is, however, moderated by gender and age in a way that it is much stronger in men, and especially, in younger men.

b. Effort Expectancy

Effort expectancy is "defined as the degree of ease associated with the use of the system" (Venkatesh et al., 2003, p. 450). The positive effect of effort expectancy on behavioral intention to use the system is likely to be more salient in the first phases of implementation, while it loses its importance later, when instrumentality issues become more relevant. Furthermore, this effect is also moderated by gender, age, and experience. Namely, this factor is a better predictor of usage intentions for women, and especially older women with less experience in technology use. Therefore, older women with less experience are likely to rely on effort expectancy.

c. Social Influence

Social influence is defined as "the degree to which an individual perceives that important others believe he or she should use the new system" (Venkatesh et al., 2003, p. 451). The effect of social influence on behavioral intention is limited to mandatory context and to the beginning of the implementation process. Also, it is moderated by gender and age in a way that the effect is stronger for women, and particularly older women.

d. Facilitating Conditions

Facilitating conditions are defined as "the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system" (Venkatesh et al., 2003, p. 453). Although facilitating conditions increase the usage intention (only in the first phases of implementation), it seems that this effect is completely mediated by effort

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expectancy. However, facilitating conditions have a direct influence on use behavior above and beyond the effect mediated by behavioral intentions. Furthermore, this effect is moderated by age and experience. Namely, for older workers, along with increasing experience, the predictive validity of facilitating conditions on usage behavior will be stronger.

Although previous studies have found significant effects of self-efficacy and anxiety, the UTAUT model does not include these constructs. The reason is that their effects on behavioral intention are completely mediated by effort expectancy, which means that these variables do not contribute to increase of variance explained. Similarly, attitude toward using technology is also omitted from the model because its effect is probably fully mediated by performance and effort expectancy. UTAUT model was shown to be highly valid in both the original sample and in additional sample used for cross-validation, with up to 70% of variance explained (Venkatesh et al., 2003).

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Figure 7. *Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh et al., 2003)*
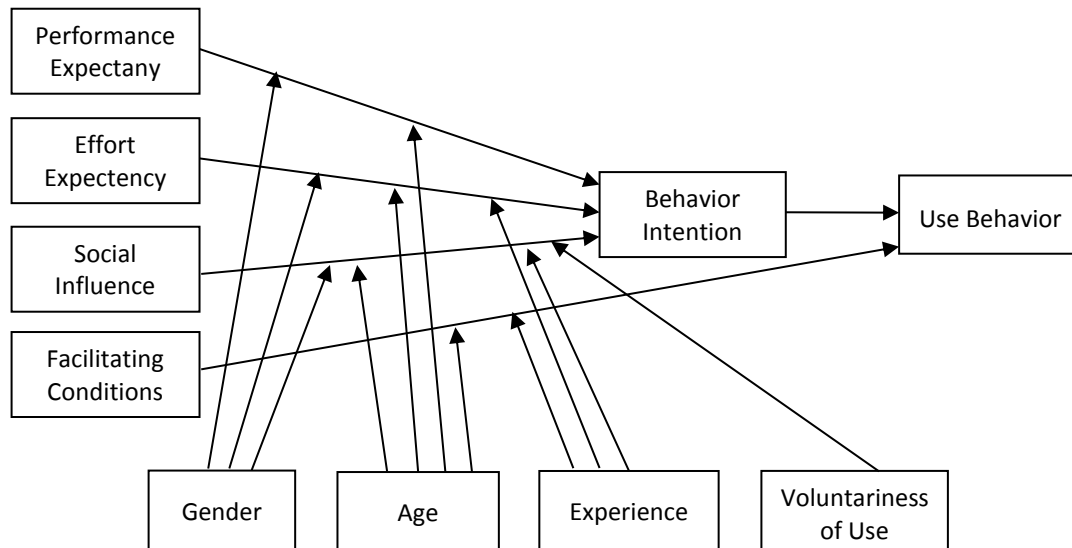
Other studies have also showed that the perception of technology is quite important for its use. For example, the perception of relevance of technology for the subject content is an important factor of ICT adoption and integration (Hutchinson & Reinking, 2011). Teo (2011) found that attitude was determined by perception of usefulness and ease of use, in line with the Technology Acceptance Model (Davis et al., 1989). Our study showed that teachers perceive external (infrastructure, technical and pedagogical support, lack of educational materials, lack of teaching models for ICT implementation, resource management) and internal (problems with ICT integration into curriculum, pressure to prepare the students for state graduation exams, lack of teachers' interest, questionable benefits from ICT use) barriers to ICT use evenly (Center for Applied Psychology, 2015b). Teachers' perceptions of benefits of ICT use in teaching and learning were predicted by student-centered teaching approach, perception of benefits of ICT use in everyday life and self-efficacy in ICT use. Teachers perceptions of risks of ICT use in teaching and learning were predicted by general perception of risks associated with ICT, teacher-centered teaching approach and low self-efficacy. Importantly, perception

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of benefits of ICT use in teaching predicted its frequency (Pahljina-Reinić et al., 2016). Also, Tablet use was related to perception of more positive and less negative aspects of ICT use (Kolić-Vehovec et al., 2015). In a smaller study (Center for Applied Psychology, 2015a), we found a shift towards less negative perceptions of ICT use during the school year, which indicates the change in attitudes after getting to know and use technology.

In a Croatian research (Purković, 2016), effects of educational context and contextual approaches on goal realization in Technical Culture were studied. Among other things, this included the effect of ICT use in teaching on these goals. Technical Culture teachers emphasized that ICT was important for two goals: students' interest for the subject and students' attainment in other subjects. They judged that ICT was moderately important for students' attitude toward school. Teachers perceived that ICT use was not particularly crucial for students' development of psychomotor skills and working and social relationships, their understanding of rules and importance of work for the society and community. Surprisingly low perception of importance of ICT use was found for students' collaboration, socialization processes, application of knowledge, creativity, and metacognitive skills. The author concluded that ICT motivates students' work in Technical Culture, but is more important in other subjects. The author also emphasizes that obtained results might indicate low support (organizational, professional) that could improve different opportunities that ICT brings to educational process.

Furthermore, Ertmer (2005) suggested that teachers' beliefs are a very important factor that determines how a technological innovation will be used in reality. That is, if the new technology is very different from their system of pedagogical beliefs, chances are that they will use the technology (if they use it at all) simply as a replacement or addition to more traditional tools. In other words, they will not make any significant change in their approach. They will only have a more modern apparatus for it. However, the author suggests that this tendency could be understood as a transition phase. Namely, technological innovation should be

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presented in a way that it fits in the teachers' worldview (see also previous section on 'Compatibility with needs and values'). In that way, they will at least consider using it. In time, this could lead to conceptual change in pedagogical approach (Ertmer, 2005). More specifically, after a phase of technological integration, ICT could be integrated in a way that it shifts teachers' methods towards more modern pedagogies such as collaborative learning, student-centered approach, problem-centered teaching, etc. This would not only embody the true meaning of ICT integration, but would have more robust effects on educational process and outcomes. In terms of Britten and Cassady's (2005) continuum which varies in the level to which teaching is dependent on technology, the above mentioned shift would mean the adoption of 'essential use of technology'. To be more informative, the proposed continuum includes three levels of technology use:

a. Non-essential use of technology includes those teaching and learning activities that could easily be performed without technology.

b. Supportive use of technology refers to those activities that support the selected teaching and learning activities, but are not absolutely necessary for the learning goals.

c. Essential use of technology includes those teaching and learning activities which could not be accomplished without the use of technology.

One of important aspects of teachers' professional knowledge, besides achieving the fit between technology, pedagogy, and content, is their ability to use technology in essential way (or at least supportive way; Heitink, Voogt, Verplanken, van Braak, & Fisser, 2016). This might be supported by teachers' appropriate reasoning behind their choice of a certain technological tool for teaching. Additionally, reasoning behind the decision should be informed by interaction with their colleagues, research findings, and examples of good practice (Heitink et al., 2016).

Furthermore, teachers' beliefs about technology are most likely to change due to influence of their peers which indicates that it is necessary to provide enough time

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for teachers to explore new technologies in interaction with their colleagues (Ertmer, 2005). More recent literature (Petko, Egger, Cantieni, & Wespi, 2015) also emphasizes the importance of peer-learning and experimentation for change of teachers' beliefs. In other words, teachers need the time and the freedom to explore these new tools in their 'natural habitat', that is, among their colleagues. This provides them with the opportunity to gain skills in a more informal and stress-free environment, and also to witness the examples of good practice from their associates who they trust and respect. Luckily, technological process enables teachers to broaden their peer-group almost infinitely. As stated in the IETE final report: "Technological advances have expanded the potential scope and depth of collaboration and information sharing among teachers, administrators and educational researchers... Added-value elements of on-line communities of practice include the ease of asynchronous communication, the inclusion of participants from a large geographic area, the ease of access, the digital archiving tools, and the materials and discussions that were posted or took place in the past" (Bakia, Murphy, Anderson, & Trinidad, 2011, p. 38). Members of the virtual communities are not bounded by geographical area, age, gender, or any other category. Technology enables them to find others with similar interests, and share ideas, knowledge, and develop educational materials through interactive and collaborative process. Naturally, these communities of practice are not restricted to the virtual environment – the same processes are warranted for in 'real life'.

There is another kind of beliefs which are important for the decision to adopt ICT, and which particular devices to choose. These beliefs, however, refer to students instead of the technology itself. To be more specific, there is a strong belief among teachers that students are already engaged in using digital technologies, and they base their decisions about teaching on this belief. Teachers believe that today's young people (i.e., students) have the abilities to confidently use ICT, and that they are motivated to use it in learning, too. The choice on which technologies to use, and how to integrate them in the lessons are based on the teachers' perceptions of how

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engaging they will be for the students and how much they will support their learning. However, teachers and students often evaluate the same experiences differently. Sadly, this is ignored in studies which rarely ask students to rate the level of their engagement. More often, student engagement is reported by teachers or observed by researchers (Howard, Ma, & Yang, 2016). Nevertheless, teachers' beliefs about the level of students' experience, competence, and interest in using particular technologies can affect their decision whether to use it.

Teachers' attitudes towards technology in general, and educational technology in particular, influence ICT adoption and integration (Buabeng-Andoh, 2012). For example, Demirci (2009) showed the crucial role of teachers' attitudes and beliefs towards technology. Despite objective barriers such as lack of hardware and software, geography teachers' attitudes towards GIS (Geographic Information Systems) were able to overcome these obstacles and lead to successful integration into lessons. That is, teachers that have positive attitudes towards technology are probably more motivated to use it, and are likely to find an alternative way to provide their students with these different experiences even without the latest infrastructure. However, it is interesting to consider Bingimlas' (2005) view of negative attitudes and resistance to change. He argues that resistance is not a barrier itself, and that it would be better described as an indicator that "something is wrong", e.g. lack of education, lack of time to make sense of the new technologies etc. In other words, if the teachers resist adopting a technological innovation, it might be useful to scan in order to detect more objective sources of barriers for integration.

2.1.4. Teaching Experience

In a review of studies on the use of ICT by teachers, Buabeng-Andoh (2012) discusses the complex and unclear role of teachers' experience as a predictor of ICT integration. Most researches indicate that teachers' experience in teaching is positively related to the level of actual and successful use of ICT in teaching. The

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rationale is following; it may be easier for older and more experienced teachers to integrate ICT into their lessons because they are already experts in their respective subjects and have enough cognitive capacity to deal with the demands of ICT use. Less experienced teachers still have to dedicate their attention and efforts to content, teaching plan, class management, etc. Additionally, more experienced teachers might be more adept in the way they integrate technology into their lessons. In other words, due to their better subject content knowledge and understanding, they might use ICT in more meaningful ways. That is, they might engage in 'essential use of technology' (see also section 'Teachers' perceptions, beliefs, and attitudes'), i.e. using technology in way that it is so appropriate for the content and teaching, that it is impossible to carry out the lesson in the same way without it. On the other hand, less experienced and probably younger teachers could be more familiar with technology, which would enable them to use it efficiently in class. As Buabeng-Andoh (2012) reported, there are some studies that are in accord with both of these hypotheses, while others found no effect of teaching experience at all. The role of teachers' experience in ICT use still seems to be unclear.

The results from our study (Center for Applied Psychology, 2015b) showed that teachers' experience has a relatively strong effect on ICT use for teaching. Specifically, teachers with more experience use technology less, which is in line with their lower self-ratings of digital competencies and self-efficacy.

2.1.5. Teachers' Experiences in ICT Based Learning Activities

Quite expectedly, teachers' previous experiences with technology in general, and education-related technology, are related to ICT use in school (Dhir, Gahwaji, & Nyman, 2013). This relation is probably due to the role of teachers' ICT skills. That is, teachers who are more experienced in ICT use are more likely to have better digital competencies. However, experience could affect ICT integration through other variables as well. For example, teachers who use technology longer had more opportunities to witness all the potential and benefits that it brings. Also, familiarity

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with technology is likely to decrease fear of it and of its potential negative consequences for students or educational process and outcomes. Ifenthaler and Schweinbenz (2013) proposed a moderating role of teachers' experience with ICT in way that it leads to a change towards a student-oriented teaching practice.

The current state in EU is diverse (European Commission, 2013). As will be specified later on (see section 'Teachers' use of ICT'), the results from Survey of Schools indicated that most students (75%) in the EU were taught by experienced teachers with more than four years of using ICT at school. Teachers with less than one year of ICT experience were quite rare. A substantial proportion of students (from 30 to 45%) was being taught by teachers who used ICT for teaching preparation (every day, almost every day, or at least once a week). Teachers also often used the school website or virtual learning environment. However, teachers which communicated on-line with parents, posted homework on-line, assessed students using ICT, or evaluated digital resources were in a minority. That is, from 60 to 85% of students were taught by teachers who never or almost never engaged in these activities. In short, many European students were taught by teachers that are not very experienced with ICT, especially ICT related to learning and other professionally related processes.

2.1.6. Gender

Most studies showed that teachers' gender is an important variable which determines the level of ICT use in teaching. According to Jamieson-Proctor and Finger (2008), gender has a direct effect on likeliness of ICT use. Specifically, female teachers are less likely to integrate technology into their lessons. Furthermore, this effect is partially mediated by confidence in using ICT for teaching and learning (Bingimlas, 2005; Jamieson-Proctor & Finger, 2008) and possibly, by anxiety (Bingimlas, 2005). That is, female teachers are less confident and more anxious about using technology in their lessons. Female teachers believe that they will not be able to successfully use ICT in class, unlike their male colleagues. They are also more often

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anxious about ICT integration, which is probably partly a results of lower confidence. These two factors, i.e. lower confidence and anxiety lead to lower motivation for ICT use in class. Some authors also mentioned the role of lowered interest of female teachers in technology (Buabeng-Andoh, 2012). That is, these authors consider the possibility that female teachers' lowered interest in technology can account for their less use of it in education. Very few studies report gender difference in ICT use in the opposite direction (Buabeng-Andoh, 2012), while some show no effect of gender on ICT use (Jamieson-Proctor & Finger, 2008). This gender gap in technology integration in educational process is quite important, because most of the teaching staff (especially in elementary schools) consists of female teachers. It would, therefore, be very important to reduce this difference. The above mentioned findings indicate that by influencing female teachers' interest, confidence, and anxiety related to technology, changes in ICT use in teaching may follow. However, additional studies are warranted, for there may be other possible causes of lower use by female teachers. It is also interesting that digital competencies were not mentioned as a factor which affects their ICT use, which indicates that lower confidence and higher anxiety may represent a female teachers' bias in perception and evaluation of their ICT skills. More specifically, it seems that female teachers underestimate their own digital competencies, which is in accord with results of our study (Center for Applied Psychology, 2015b) where female teachers provided lower self-ratings of digital competencies.

2.2. School-Level Factors

2.2.1. ICT Infrastructure and Its Quality

ICT infrastructure, i.e. hardware and software, is a necessary condition for integration into lessons. This factor is overwhelmingly brought up both in literature reviews (e.g., Buabeng-Andoh, 2012) and empirical studies (e.g., Dhir et al., 2013). Although the mere existence of technology in schools is definitely not a guarantee

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that it will be used, (especially not appropriately), ICT equipment usually does motivate school staff to adopt it (Balanskat et al., 2006). Therefore, providing the schools, teachers and students with appropriate and quality equipment, is a natural first step toward ICT integration into educational process.

According to Survey of Schools' results (European Commision, 2013), a highly digitally equipped school is a school that has relatively high equipment levels, fast broadband (10mbps or more) and high 'connectedness' (has a website, email, a virtual learning environment and a local area network). For adequate ICT infrastructure, an important factor is the availability of computers for educational purposes in school. A computer can be desktop or laptop, netbook or tablet computer, connected to the Internet or not. On average in the EU, there are between three and seven students per computer, and in most countries, the older the student, the lower the student to computer ratio. There are on average over 100 students per interactive whiteboard and 50 per data projector. Also, there are more than nine out of ten students in schools with broadband (generally from 2 to 30 mbps). Mostly, schools are connected at a basic level, meaning that they have a website, email for students and teachers or a virtual learning environment. It is still a matter of urgency in some countries to develop policies to support better infrastructure. Compared with The ICT Impact Report (Balanskat et al., 2006), there are around twice as many computers per 100 students in secondary schools, but the wide variations between countries are still persistent in 2012. Unlike in 2006, laptops and interactive whiteboards are now much more present, but there is also a trend towards smaller and portable computers, and away from desktop computers to laptops and mobile phones. Findings from Survey conducted in 2012 suggest that education systems are responsive to technological trends, for example implementing equipment policies that reflect recent trends in mobile devices (laptops, netbooks, tablets, etc.). Furthermore, broadband is in 2012 almost omnipresent compared to less than three-quarters of schools in 2006. At all the

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levels of education surveyed, the percentages of schools with websites, email for students and teachers have increased.

In comparison with EU, Croatia was below the average when it comes to the number of computers available at all grades (European Commision, 2012). The trend indicated that older students have more computers available is also reflected in Croatia, but only in secondary vocational schools. Croatia is in the lower group of countries at both primary and secondary schools. Also, regarding computers connected to the Internet, most computers in Croatian schools are desktops, with relatively few laptops, and the number of Internet connected computers is considerably below the EU average at all grades. In primary and secondary schools in Croatia, computers are located in dedicated labs, which puts it among the highest percentages (70%) in the EU, but is the lowest at grade 8 when it comes to percentages of students (30%) in schools where over 90% of computers are operational. Only few students in primary schools have access to interactive whiteboards (secondary schools in Croatia come close to the EU mean). When it comes to broadband in Croatian schools, the percentages of students in schools with broadband speed faster than 10 mbps is close to the EU average at grades 8 and 11 general, and even higher at grades 4 and 11 vocational. The percentage is also above the EU mean at grades 4 and 11 for schools with more than 100 mbps. The Surveys' findings show that in Croatia, percentages of students in schools that are 'connected' (have a website or a virtual learning environment) is higher than the EU mean at all grades. However, regarding schools having a virtual learning environment, Croatia is notably lower than the EU average at all grades, except grades in secondary schools where it is close to the EU mean. Also, few students are in schools with local area networks. As can be seen, Croatia is mostly below the EU average when it comes to ICT infrastructure. Therefore, although there certainly is some progress, additional effort is needed to provide the educational system with the necessary devices for successful ICT implementation.

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When we consider ICT infrastructure, a second important factor is hardware quality and its maintenance. If the equipment is of low quality, and/or is not regularly serviced (see also section 'Technical support'), the teachers will not be very interested in incorporating it into their work due to "fear that something might go wrong" during the class (Balanskat et al., 2006). Furthermore, technical breakdowns do not only affect ICT use through increased teachers' anxiety. Simply put, if something does not function properly, it is quite logical not to risk wasting time in class on this low quality piece of equipment. So, it is not only important to increase the number of computers, interactive whiteboards etc. It is equally necessary to choose good quality hardware and software, in terms of its appropriateness for education (more on the importance of educational software later in this section).

Another related factor refers to teachers' ICT accessibility. Although low access to ICT can to a certain degree be a direct consequence of lack of hardware, it is often a result of poor organization of resources. Namely, the devices may be locked into specialized rooms, the schedule of using them may be inappropriate etc. (Bingimlas, 2005). Low access to technology due to bad resource management is equally detrimental to successful integration as is complete absence of hardware. National survey in US (Hutchinson & Reinking, 2011) showed that literacy teachers perceived lack of access to technology as one of the most important obstacles to ICT integration. In teachers' view, factors that enable ICT use include access to personal laptop, availability of high quality resources, unlimited access to software and hardware, effective timetabling of rooms and equipment, and access to interactive whiteboard (Scrimshaw, 2004). All of these factors reflect the issue of accessibility. Therefore, it is essential for schools to govern their technological resources wisely, for it is easy to image well-equipped schools with lower levels of ICT integration than a school with more modest infrastructure, but better management.

Finally, availability of appropriate educational software can hinder the use of even the best devices and successful technological resource management. If this software is not in accord with the specific requisites of the subject, or is non-existent, the

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hardware is useless (Balanskat et al., 2006). More specifically, teachers need software that will be designed for the particular needs of educational application of technology. Although there are all-purpose programs that the devices offer, which are useful for teaching and learning, much more can be done with applications that are specifically made for teachers and students to use, with specific educational goals, and for specific subjects. It would be unrealistic to expect miraculous effects of all-purpose devices for such a distinct environment as the school is. For example, Clarke and Svanaes (2012) report about the dissatisfaction of teachers with lack of appropriate content for teaching with tablets. They feel that applications are often simply a digital copy of a book. In other words, the potentials of technology are not fully realized. "Across the three Tablet schools there appeared to be a sense of frustration with the educational publishing industry for not fully engaging with the potential of interactive content. All three schools had been in contact with publishing houses and wanted to collaborate and share their knowledge about what content is needed, but felt that developments in this sector were far slower compared to the app developing industry in general. … Teachers spoke of publishers merely transferring a book into a PDF file, and thus taking no advantage of the opportunities offered by the Tablet" (Clarke & Svanaes, 2012, p. 41). Therefore, besides providing the schools, teachers, and students with hardware which is well-organized on the school-level, it is crucial to grant appropriate software. Unfortunately, this factor is usually beyond the control of schools.

2.2.2. Technical Support

A factor related to the issue of equipment quality is availability of technical support. Namely, low quality devices and/or infrequent maintenance result in more common breakdowns. Furthermore, if technical support on spot is not available, teachers will be discouraged from using ICT in their lessons. This is probably a result of fear and anxiety that such a failure will happen during the class (Buabeng-Andoh, 2012). In other words, fear that 'things might go wrong' is "likely to prevent teachers from attempting to use the technology at all, even before there is a chance for any

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potential technical problem to occur." (Jones, 2004, p. 16). This is a very natural reaction, especially for teachers that are not exceptionally proficient users of technology. For them, mere use of technology is stressful and challenging enough. If they estimate that potential breakdowns are likely, which would require on-spot intervention (which is not available), it is quite logical for them to completely give up the idea of ICT integration. According to national survey in US (Hutchinson & Reinking, 2011), literacy teachers perceived this as one of the most important obstacles to ICT integration, a finding which adds up to previously mentioned reasoning. Similarly, in a study by Ifenthaler and Schweinbenz (2013), all interview teachers expressed "the need of a smoothly running technical infrastructure as a prerequisite for TPC [Tablet-PC] use and a majority of respondents need a supporting infrastructure while using TPC in classroom instruction" (p. 533). Therefore, in order to motivate teachers for ICT use, it is essential to provide necessary conditions in which they will feel secure and protected while incorporating innovations into their teaching. In other words, they need to know that the devices that they use are not subject to errors, failures or other problems which might affect the quality of their lesson. When these complications do happen, they need to know that they have appropriate professional support.

2.2.3. Appropriateness of Teacher Training

The authors overwhelmingly agreed on the issue of the importance of adequate teachers training and professional development opportunities (Balanskat et al., 2006; Buabeng-Andoh, 2012; Dhir et al., 2013; Tolani-Brown et al., 2008). As Balanskat et al. (2006, p. 51) put it, "Developing the skills to engage effectively with the technology and creating structures to enhance ICT use is as important as investing in ICT infrastructure." However, they also emphasize that the most frequent failure of teachers' training is that it is focused only on development of ICT skills, and usually does not tackle the question of integration of ICT into lessons, that is, the pedagogical aspects of ICT are ignored. A complete, comprehensive, and

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adequate professional development training should include education of teachers in how to use the technology. But, solely focusing on digital competencies is not sufficient. Teachers need to be provided with information about the ways in which they can use these skills in teaching. Furthermore, educators should provide them with the knowledge about the selection of appropriate technologies which will fit to the content of their subject, their teaching approach, and ways in which it can be used 'essentially' (see section 'Teachers' perceptions, beliefs, and attitudes'). This is also perceived by the teachers themselves. For example, a national US survey (Hutchinson & Reinking, 2011) showed that literacy teachers perceive lack of professional development on how to integrate technology one of major obstacles to ICT integration. In other words, teachers are aware of their need to receive not only education in how to use the technology, but also how to integrate it into their subjects. However, it would not be wise to underestimate the importance of ICT skills training (see section 'ICT skills'), especially for teachers that did not receive this kind of instruction during their formal education (Balanskat et al., 2006; Bingimlas, 2005). This group of teachers might benefit from the professional development program in which the focus is on digital competencies advancement. Furthermore, teachers could also benefit from additional time to experiment with technology and practice newly-acquired skills, as well as time for peer- collaboration and sharing (Buabeng-Andoh, 2012). When done properly, teacher training can lead to positive changes in competencies, attitudes, organizational skills and knowledge on how to implement technology into teaching. However, in US national survey (Hutchinson & Reinking, 2011) professional development on the integration of ICT into instruction was not shown to be important to increase in ICT use, while professional development on how to use ICT was found to be moderately significant. The authors refer to the need for a curricular integration of ICT, and not just technological integration. In other words, they speculate that professional development which is focused only on the "how to" part of the technology use may reinforce the use of ICT only as an additional tool, instead of using it to make substantial and conceptual changes in the pedagogical approach. However, more research is needed in order to gain

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knowledge about what professional development should look like (Hutchinson & Reinking, 2011). Previously mentioned Survey of Schools (European Commission, 2013) also suggests that policy makers at national, regional, local and school level should be strongly recommended to massively invest in teacher professional development as a necessary accompaniment to implementing ICT infrastructure into schools. Efforts should be made to reduce obstacles and provide high access to ICT use at school, while at the same time investing in teacher professional development and regularly discussing with teaching staff about ICT use for teaching and learning. The fact that teachers' professional development can produce huge benefits and effects is supported by the overwhelmingly positive opinion of teachers about the value and effect of ICT on teaching and learning.

At the time of data collection, across the EU, only about 25-30% of students were taught by teachers for whom ICT training was obligatory. In over half of EU countries, ICT training is a part of initial teacher education, but it also varies according to the higher education institutions, who are often free to adopt their own approach. On average in the EU, around 70% of students in primary and secondary schools are taught by teachers who have engaged in personal learning in their own time about ICT. In Croatia (European Commision, 2012), teachers who have invested more than six days in professional development activities during the past two years teach fewer students in almost all grades, compared with the EU mean. Only in secondary schools the situation in Croatia is closer to the EU average. However, compared with the EU mean, more students in Croatia are in schools where teachers have spent between 1 and 3 days on ICT professional development activities, and those who have spent no time are below the EU mean both in primary and in secondary schools. Moreover, when considering the percentage of students taught by teachers who have recently (during the past two years) undergone ICT training provided by the school staff, Croatia is positioned significantly higher than the EU average at all grades, especially so at grade 4, but lower at almost all grades, regarding teachers who have undertaken personal training or training via on-line communities. Furthermore,

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Croatia is among the top third of countries when it comes to percentages of students taught by teachers for whom ICT training is obligatory. When it comes to teachers' involvement in personal learning about ICT in their own time, the Survey places Croatia among the middle group of countries at all grades (except grade 8). Considering teachers' participating in training provided by school staff, Croatia is placed in top two countries at all grades (except secondary general schools, in which case it ranks fifth). Also a positive finding was that Croatia is placed below the EU average when it comes to percentage of students (1-9%) taught by teachers who have not spent any time on ICT-related professional development activities during the past two years. Despite this, the image of Croatia in terms of teachers' training is not very bright. As was presented by the Survey's results, Croatia is under the EU mean in most of the indicators. Another question could be posed about the content, structure, and focus of these professional development programs. Following what has been elaborated about the importance of both digital competencies and ICT integration training, we do not have the information on the frequency of these topics.

It seems that many countries recognize the importance of adequate teachers' professional development programs. Namely, the results of a large-scale study "International experiences with technology in education" (Bakia et al., 2011) showed that many countries cite that using technology to accomplish teachers' professional development as a priority. Two specific priorities related to this, and which are reported at the highest frequency are improving teachers' pedagogical skills, and reinforcing teachers' ICT integration into educational process. What is more, all 21 participating countries put this as a priority, while 17 having national programs to realize this goal. Austria, Chile, Denmark, France, Iceland, Israel, New Zealand, South Korea, and Sweden also enable teachers to benefit from formal on-line or blended courses. These programs are intended to tackle one of the two previously mentioned 'top priorities', i.e. advancement of pedagogical skills or increasing abilities to integrate technology into teaching.

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In conclusion, teachers' professional development is clearly seen as a crucial factor for successful ICT implementation by multiple relevant parties. Although there are valuable activities taking place which aim at realizing those trainings, their frequency and type is still not at a satisfactory level, especially in Croatia. Efforts should be made for more teachers to gain training in both digital competencies and ICT integration. Those planning, organizing, and executing these programs should also bear in mind specific needs of different groups of teachers.

2.2.4. Policies, Support and Strategies in Schools

In previous sections, arguments have been presented that add up to importance of teachers as main agents of ICT integration in schools. This would imply that the process of implementation follows a 'bottom-up approach', i.e. that the use of ICT will increase at the school-level when it starts at the individual level. However, many authors emphasize the importance of the so called 'top-down approach'. In other words, school leadership which includes planning, a whole-school approach to access to and sharing of resources, whole school policies on using ICT across curriculum (Scrimshaw, 2004), clear institutional direction concerning course design (Birch & Burnett, 2009), support etc. (Tolani-Brown et al., 2008) is a very important factor which contributes to teachers' ICT integration in lessons (Buabeng-Andoh, 2012). According to literature review by Buabeng-Andoh (2012), leaders have to implement technology plans and share a vision with the teachers. Furthermore, leaders' promotion of collaboration and experimentation leads to successful ICT integration. It seems that this top-down approach is crucial for successful integration of ICT. Namely, although there are some positive effects from individual teachers and administrators developing their own approach to ICT implementation, this effort is usually beyond their capacities. Considerable effects are mostly a result of coordinated planning and actions of higher instances (e.g. schools, regions, state) (Venezky & Davis, 2002). A recent study by Petko et al. (2015) provides further evidence. Namely, it seems that adoption of ICT in schools is highest when a

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combination of top-down and bottom-up approach is used. To be more specific, all levels included must work together, i.e. administrative units, school leadership and teaching staff. This combined approach is superior to any of the elements. However, findings show that in schools with exclusive top-down approach, ICT adoption is higher than in exclusively bottom-up-approach schools. This does not mean that individual level (in most cases teacher-level) variables are irrelevant. Quite on the contrary, as it was explained in the section 'Teacher-level factors', many characteristics and judgments of teachers are crucial for the level of ICT use. However, when it comes to technology integration initiatives, it seems that individual efforts are in need of a higher-level support, that is, support from school, local community, government etc. Support may include both help in acquiring infrastructure, but also detailed regulations and strategies about the integration process.

The Survey of Schools results (European Commission, 2013) indicated that students, as well as teachers, show the highest frequency of ICT use and ICT learning based activities during lessons when their schools have policies about ICT integration in teaching and learning generally speaking as well as in subject learning, when schools use incentives to reward teachers using ICT, implement concrete support measures which include teacher professional development and when schools provide ICT coordinators. Importantly, concrete support measures in schools are found to influence students' frequency of ICT use during lessons more, compared to schools with policies but no concrete support measures. Such observation is probably related to the fact that policies are still defined at central level in several education systems and have not necessarily been reported at school level. Schools that have policies and/or concrete support measures are defined by The Survey as digitally supportive schools. Across the EU countries covered by The Survey, on average between 25-30% of students are in digitally supportive schools developing policies as well as concrete support measures. When adding students in digitally supportive schools which mostly focus on concrete support measures, this percentage goes up to between 40-

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50% of students. Percentages of students in digitally supportive schools in Croatia are slightly below the EU average (European Commision, 2012). When considering schools with strong policy and strong support at grade 8, Croatia is positioned last among surveyed countries. However, although more than 40% of students are in schools with strong support, the majority of students are still in schools with weak support.

One of the positive surveys' findings (European Commission, 2013) is that schools are increasingly adopting policies about responsible Internet use and the use of social networks for teaching and learning. Majority of students (60%) are in schools where there is a policy about the responsible use of the Internet, but a minority of them (40%) are in schools with policies about safe Internet use. Schools in surveyed countries have developed plans and measures to support collaboration among teachers to a limited extent, but still not concerning the large majority of students. On average, around 50% of students are in schools where there is a policy to promote cooperation among teachers or at least have scheduled time for them to share, evaluate or develop instructional material and approaches. When comparing implemented ICT strategies in participating countries, Croatia is placed in the bottom four countries for primary and secondary general schools, and last in secondary vocational schools. Below average of ICT strategies are implemented in Croatian schools. However, high percentages of students are in schools with developed strategies to support teacher collaboration, but are below or in the middle group of countries for strategies about responsible Internet and social media use (except grade 4 where Croatia ranks highest), and for change management programs in both primary and secondary schools. Furthermore, there are fewer students in schools in Croatia where ICT coordinators are provided, compared to the situation in the EU. In Croatia majority of students are in schools that employ ICT coordinators full time, but percentage of students in schools where ICT coordinators provide pedagogical support is below or close to the EU mean (European Commision, 2012). Croatian schools are obviously below the EU standard in most indicators related to policies,

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support, and strategies for ICT integration in schools. In light of previously mentioned findings, this does not represent a fertile environment for successful ICT integration.

2.2.5. Climate for ICT in Schools

Climate for ICT in schools is a construct arising from the wider area of psychosocial and organizational climate studies, or research on the psychological meaning of the events and characteristics of individuals' social environment. Namely, since the individual reacts to a particular situation in terms of the meaning that he or she has about that situation, the interest of researchers and practitioners in the field of organizational psychology to explore the climate of different social environments is understandable. This is best evidenced by the extensive theoretical and empirical literature on the subject. Therefore, construct of psychosocial or organizational climate has a long history in psychological theory and practice.

Numerous and various conceptualization and operationalization of this construct are a natural consequence of desire of researchers and practitioners to specify and change the environmental influences on the motivation and behavior of employees. Schneider (1990) defined organizational climate as "employees' perceptions of the events, practices, and procedures and the kinds of behaviors that are rewarded, supported, and expected in a setting" (p. 384). This definition suggests that the climate is actually a common description of everyday experience of how employees are treated in the organization in which they work, and on the way they view their relationships.

Most climate researchers start from the simple assumption according to which the different social environments can be described using a limited number of the same or similar dimensions or climate factors. Typically, the climate is measured using a questionnaire, inventory or scale, which are composed of a large number of items that describe various aspects of the situation in the organization (events, procedures, rules, relations). The task of the respondents is to estimate to what

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extent the proposed scales describe their organization. This quantitative approach dominates the research of organizational climate, and a large number of questionnaires has been developed to measure the climate in organizations from various business sectors, including educational institutions or schools.

According to numerous research results, climate is related to the organizational and psychological processes, such as communication, problem solving, decision-making, conflict management, learning and motivation (Sušanj, 2005). In this way, the climate directly or indirectly exerts an influence on the efficiency and productivity of the organization, its capacity for innovation, and the job satisfaction and other attitudes towards the work of its employees. In the model of culture, climate and productivity offered by Kopelman, Brief and Guzzo (1990), climate, as a consequence of human resource management, has direct effects on the cognitive and affective states such as work motivation and job satisfaction and, indirectly, on organizational behavior in terms of performance or absenteeism. Recent studies generally confirm the hypothesis of the complex mediating and moderating role of the climate (Schneider, Ehrhart, & Macey, 2011), so it can be concluded that the climate is an intervening variable that has an effect on the attitudes and behavior of the members of the organization.

School climate is based on patterns of students', parents' and school personnel's experiences of school life and reflects norms, goals, values, interpersonal relationships, teaching and learning practices, and organizational structures (Thapa, Cohen, Guffey, & Higgins-D'Alessandro, 2013). Just like in other organizations, research confirms the beneficial effects of a positive school climate. It is associated with and/or predictive of academic achievement, school success, effective violence prevention, students' healthy development, and teacher retention, and promotes safety, healthy relationships, engaged learning and teaching and school improvement efforts (Cohen, McCabe, Michelli, & Pickeral, 2009). While in the United States there is a National School Climate Center (NSCC) that systematically promotes the measurement and improvement of the positive school climate, in our

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country the research on school climate are rare, wherein Domović (2003) stands out. She studied the relationship between school climate and other school variables such as student achievement, motivation, job satisfaction of teachers and management of the school.

Recent approach, which includes the so-called facet-specific climate (e.g. climate relating to the safety of the work or the quality of service delivery), representing a step forward compared to the traditional concept of climate as undifferentiated summary perception of the organizational environment. These studies are on the trail of Schneider and Reichers (1983) view, which require that we have to determine accurate frame of reference for the climate we investigate: the climate is "for" or "in relation to" something. Schneider, Bowen, Ehrhart, and Holcombe (2000) also claim that an important characteristic of organizational climate is that it is focused. More specifically, climate is always 'for something', which refers to organization's characteristics that enable or hinder implementation of an idea, process, value, or anything of interest. Previously, the research has included climate for safety, climate for service, climate for implementation, climate for innovation, climate for fairness etc. This approach has bolstered the research on effects of specific type of climate on specific work outcomes. For example, climate for safety refers to the expectations of behavior that ensure safety in the workplace and intends to influence such behavior (Zohar, 1980). Climate for fairness is defined as an organizational climate that encourages righteous behavior and focuses on the expectations of the environment of fairness, and it is expected that such expectations affect the just conduct in the organization (Ambrose & Schminke, 2007).

Although climate refers to employees' perceptions, which makes it a psychological variable, it is also a social variable, for it reflects attributes of the organizational setting (Schneider et al., 2000). "Climate is a picture of a work setting, developed by individuals working in it, and based on leaders' behaviors and organizational rules, procedures and expectations of that setting" (Zappalà & Sarchielli, 2006, p. 41). There are findings that indicate that organizational climate could be an important

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determinant of ICT adoption. For example, it was found that organizations which incorporate ICT into their business plans have higher scores on all dimensions of climate for innovation (i.e., shared organizational goals, task orientation, effort to introduce new and improved ways of doing things in the workplace), compared to organizations that do not consider ICT in their business plans.

Schools, although specific, also represent a type of organization. Therefore, similar effects of climate in schools can be expected in the context of ICT adoption. In other words, attributes of schools and staff's perceptions of the degree to which ICT use is expected and praised is likely to determine the level of real ICT use. Leadership plays an important role in 'climate for ICT implementation' formation, but not exclusively. As was previously mentioned, organizational climate is a construct determined by all individuals working in it, as well as formal and informal regulations. Therefore, in order to increase the levels of ICT adoption and use in schools, it is important to consider school climate for ICT.

2.3. System-Level Factors

2.3.1. Structure of the Schooling System

Even if teachers are opened and ready to accept technological innovation, the structure of the system might impede ICT integration (Bingimlas, 2005). Namely, students' skills which could potentially develop while using ICT in education are usually not as valued in the final exams as is the content, acquired with more traditional teaching methods. This can demotivate teachers to integrate ICT, especially with grades which are crucial for children's educational path (e.g., Key Stage 3 in UK; Harrison et al., 2002) (Balanskat et al., 2006). Both teachers and students naturally focus on acquiring knowledge and skills which determine students' future. This is especially pronounced in grades which represent sort of a turning point in educational process (e.g., in Croatian system, those would be 5th, 6th, 7th, and 8th grades in elementary school, and state graduation exam at the end of 4th

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grade of high school). In other words, the nature of the schooling systems implicitly pressures teachers and students to focus on one set of skills which will bring students the 'grades' and 'points' needed for the subsequent educational levels. However, this does not guarantee that knowledge and skills acquired in this process are relevant or appropriate in modern world. Parallel to this, teachers and students necessarily ignore another sets of skills and knowledge which are not formally valued by the system, but might be more important for adapting to the requirements of modern work market.

Furthermore, the schooling system is generally not supportive for ICT integration. For example, teachers list lack of time as one of the most important obstacles to ICT integration (Hutchinson & Reinking, 2011). This refers to lack of time during the class, lack of time to plan and prepare for using technology, and lack of time to teach basic computing skills. In relation to this, Buabeng-Andoh (2012) mentioned teacher workload as an important factor which can affect the level of ICT use. It seems that this factor mostly functions as a barrier, for the majority of teachers are already under pressure because of the high workload. According to Buabeng-Andoh's (2012) literature review, this represents a major obstacle to ICT integration in lessons. In other words, the schooling system seems to add new requirements to the teachers (e.g., ICT integration), while removing none. Time is a limited resource and it cannot be expected from teachers to infinitely increase the number of their obligations. Otherwise, it will lead to necessary neglect of some of these tasks and/or decrease of quality of their work.

2.4. Conclusion

As can be concluded from previous sections, there are many factors that have to be in line in order for successful ICT integration to happen. Putting the equipment in the hands of teachers and students may be an important and necessary first step, but it is hardly enough. There are many subtle, different-level variables which have to be

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considered in the implementation process. What is more, it is very important to have in mind that most of these factors are correlated (Bingimlas, 2005). For example, unlimited access to ICT resources may affect the acquisition of ICT skills which are extremely important for appropriate technology use in class. Nature of the schooling system may affect teachers' perception of ICT usefulness and, consequently, the level of ICT use. Lack of or inappropriate teachers' professional development training may contribute to teachers' negative attitudes toward ICT. There are many more possible examples. However, the reality of correlation between factors is probably much more complex. This interrelatedness of numerous factors may be an obstacle itself in terms of scientific research. Namely, it is very hard to discern the unique effects of each of these factors in studies of ICT effects in education. Sometimes it is not only difficult, but also impossible to measure, and especially to control for all the relevant factors. As Balanskat et al. cite (2006, p. 24): "A causal link between one factor (e.g. the use of a specific tool) and the wider effect or an 'end-point' outcome (e.g. improved learning outcomes) is so difficult to prove with many interrelating and difficult to control variables (students' attitude, teaching processes, etc.) to be considered. It is easier to measure the more direct links between input (more Internet connections) and outputs/outcomes such as the use of the Internet. Such crucial issues may go some way towards explaining why there are few explicitly impact-oriented studies and brings out a tension underlying this study: how can relatively simple input and output measures be applied to complex social interactions taking place in schools? In the health service for example it is possible to determine the effect of a given medical intervention, to determine the cost of such an intervention and subsequently to assess, generalize and direct funding to those who adopt such best practice. Yet, without evidence of pay off, it is difficult to convince decision makers, politicians, treasury officials and voters that ICT in schools is worthwhile."

Bottom line is that correlations between these, and other unidentified factors, set a limit to detection of unique, true, and direct effects. This can also reflect to practical

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concerns. To be more specific, practitioners may put their efforts in trying to influence one factor, when it can be completely irrelevant to successful implementation of ICT because it is only related to this outcome by means of another factor.

However, one important conclusion can be taken from this review. Namely, it would be most beneficial to invest into changing factors at all levels, i.e. individual (teacher), institution (school) and system levels. This approach will probably yield best results, as indicated by a recent study from Petko et al. (2015). Such an ambitious venture requires a multi-level, highly-organized, and well-funded endeavor. Naturally, it is not to be expected that this kind of initiative would show significant changes in ICT use, adoption or integration in a very short period of time. As was previously discussed in the 'Introduction' using the framework of Rogers' model of innovation diffusion (1962/2003), for successful implementation of any innovation, time is a necessary resource. In line with this, one cannot expect any fast solutions and results in terms of measurable outcomes, for they too require an appropriate period of time.

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3. ICT IN EDUCATION

The role of ICT is becoming increasingly important in educational systems worldwide. Since global governments started making investments to improve teaching and learning with the use of ICT, educational institutions are trying to restructure their educational curricula, in order to overcome the technology gap in teaching and learning. Therefore, there is a growing demand for schools to use ICT to teach the skills and knowledge students need for the 21st century. Consequently, increasing number of studies have been conducted that investigated the integration of ICT into primary and secondary education, and its effect on the teaching and learning process.

In this chapter we review relevant literature on the effects of ICT integration into teaching and learning. Firstly, we describe students' and teachers' use of ICT in schools, mostly in European countries. Later, when describing the relationship between ICT use and different outcomes, we primarily consider ICT's effect on students and teachers. Regarding students, we report on their motivation and attitudes towards the use of ICT, the relationship between ICT and their digital competence and attainment in school, and also on the benefits of ICT use for students with special needs. Furthermore, moderators of the relationship between ICT use and student outcomes were also taken into consideration. When considering effect on teachers, we found relevant to review the effect of ICT on their teaching and learning process, their digital competence, their work efficiency and perceptions and attitudes towards ICT. Finally, in this chapter we also discuss some frequently reported disadvantages of ICT use in education.

3.1. ICT Use in Schools

Intial ICT provision, implementation and technical support in schools provide fundamental conditions for students and teachers to use ICT and potentially add value to the teaching and learning process. A detailed report on ICT access and use in schools was provided by a recent study, The Survey of Schools: ICT in education (European Commission, 2013), which aimed to

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investigate the use of educational technology in European schools, based on the results from 27 countries. It was the first study that was conducted on-line and the first that directly included students. The results showed that, with both students and teachers, there are wide variations in the degree of use of the ICT equipment available in schools.

3.1.1. Students' Use of ICT

According to the survey's findings (European Commission, 2013), students in participating countries reported they use computers at home more often than at school. Percentage of students with more than four years of experience at home was between 80% and 90%, compared to 40-60% with experience at school. Also, it was found that the use of digital resources and tools was worryingly low. Most frequently used resources were digital textbooks and multimedia tools. Yet, more than 50% of students in primary and secondary schools never or almost never used those resources, and only 30% of students used them once a week or almost every day.

As in other cases in the survey, when investigating students' use of ICT equipment in schools, there were wide variations accross participating countries. On average, more than half of secondary school students used an interactive whiteboard at least weekly in the EU. Students developed a trend of bringing their own technology to school and using it for learning, whether bringing their own technology is sanctioned or not. Bringing their own mobile phone for learning purposes at schools is something 28-46% of students in participating countries do (European Commission, 2013).

In Croatian schools there is a huge problem with the hardware because students use 6-7 year old desktop computers, and, due to the economic crisis, replacement of the hardware is problematic. However, there have been national strategies for ICT (e-learning and digital competences especially) and national research projects and initiatives for ICT. In primary schools informatics is an optional subject and in secondary schools ICT is a seperate subject, with the duration depending on the type of secondary school (vocational or general). The

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National Curriculum Framework, in addition to regular teaching informatics as a subject, integrates ICT in many subjects (European Commission, 2012).

The Survey of Schools: ICT in education gave a detailed report for each participating country, including Croatia (European Commission, 2012). According to the results of the study, students' use of computers in class in Croatia is above the EU mean at all grades (it is only slightly below in secondary vocational schools). Regarding students' use of their own laptops, Croatia is below the EU mean, while mobile phone usage is at all grades higher than the EU mean. When comparing participating countries, percentage of students in Croatia that use computers at least once a week (68%) is above the EU average (only in secondary general schools it is on average). Croatian students are very frequent in using their own mobile phones, but less frequent in using their own laptop in schools. Also, interactive whiteboards usage in Croatia is much less frequent than the EU mean in both primary and secondary schools. However, Croatia is among the middle group of countries regarding frequency of ICT-based activities during lessons.

In addition, Pregrad, Tomić Latinac, Mikulić, and Šeparović (2010) conducted a study in which they investigated the use of the Internet among primary school students in Croatia. Their results revealed that in general, 50% of students access the Internet daily, and that boys are significantly more frequent users of the Internet, when compared with girls. Moreover, they found that, regardless of gender, there is a trend of more frequent use of the Internet with relation to higher age.

Another study conducted in 20 Croatian primary and secondary schools (Center for Applied Psychology, 2015b) revealed that over 97% of students had access to the Internet at home, and 92% of them use it every day. Also, 93% of students had access to a smartphone at home, while 88% of them used it daily. Students had higher access to the Internet at home than at school. Only about 75% of students had access to the Internet in both primary and secondary schools. Also, students in schools mostly had access to desktop computers (83%). Furthermore, secondary school students had higher access to laptops, but lower access to tablet computers at school, compared with primary school students. When considering the

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use of the Internet and ICT equipment in schools, the results showed that, on a daily basis, students mostly used smartphones and the Internet. More than 85% of students reported they never use a laptop or a tablet computer in school, and only 30% reported they use smartboards in school. When considering students' reasons for using ICT, it was found that they mostly use it for social networking, searching for fun and interesting content, and browsing the Internet. Related to school activities, students mostly use ICT for exchanging content and assignments, and for searching additional content which could help them in writing, learning and preparing for class (Center for Applied Psychology, 2015b).

3.1.2. Teachers' Use of ICT

Successful implementation and integration of ICT into teaching and learning process is highly dependent on teachers' use of available ICT equipment and resources. In the Eurobarometer Benchmarking survey, it was reported that the most intensive users of ICT are teachers who teach science, mathematics and computer science, with those who teach in vocational education (Korte & Hüsing, 2006). The results from a study conducted in Croatian schools (Center for Applied Psychology, 2015b) showed that teachers who teach STEM subjects are the most intensive users of ICT for different purposes, as well as for teaching and learning.

On a European-wide level (European Commission, 2013), it was reported that experienced teachers with more than four years of using ICT at school teach around 75% of students in primary and secondary schools. It was very rare for teachers to have less than one year of ICT experience. It was also found that 30-45% of students are being taught by teachers who use ICT for teaching preparation every day, almost every day, or at least once a week. It was very common for teachers to use the school website or virtual learning environment. However, it was found that between 60% and 85% of students are taught by teachers who reportedly never or almost never communicate on-line with parents, post homework for their students on-line, assess students using ICT, nor evaluate digital resourses. Compared with the results from The ICT Impact Report (Balanskat et al., 2006), there is an increase in the percentages of teachers at all grades that have used ICT to prepare lessons and that have used ICT in class in

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the past year, however, the number of teachers using ICT in more than 25% of lessons has not increased.

In Croatia, it was found that teachers' frequency of ICT use in teaching and learning is close to the EU average in both primary and secondary schools. Croatia is positioned higher than the EU average when it comes to teachers using ICT in more than 25% of their lessons at all grades (except slightly below at grade 11 vocational). The authors came to the conclusion that teachers in Croatia are heavy users of ICT in lessons, when considering percentages using ICT in more than one in four lessons. However, only few teachers in Croatia have the experience of using ICT in class for more than six years (European Commission, 2012).

In a study conducted by Center for Applied Psychology (2015b) the results revealed that teachers in Croatian schools used the Internet and ICT equipment more at home than at school. At home, majority of teachers had a laptop (over 80%) and a smartphone (over 60%), and over 90% of them had access to the Internet. At school, teachers mostly had access to the Internet, but more so in secondary schools. Over 50% of teachers reported they used the Internet every day at school, and an even smaller percentage used desktop computers (38%) and laptops (31%) daily at school. Less than 15% of teachers had access to tablet computers, and 20% had access to smartboards at school. Moreover, the majority of teachers (90%) reported they never used a tablet computer or a smartboard at school.

Furthermore, the results (Center for Applied Psychology, 2015b) suggested that teachers use ICT mostly to communicate via e-mail, read/watch the news on the Internet or browse the Internet. When it comes to teachers using ICT for teaching and learning processes, it was found that they use ICT mostly for preparation (gathering information, searching for learning materials, preparing assignments for students). Teachers used ICT in class mostly so students could search for additional sources of information on the Internet, and so they could access the learning content. Also, it was found that secondary school teachers used ICT for teaching and learning purposes more frequently that primary school teachers.

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The findings of the Survey (European Commission, 2013) have shown the need for specific policies and actions to increase ICT use in teaching and learning during lessons. The basic condition required for this to happen is ICT equipment in the classroom, where students' learning takes place. Naturally, mere implementation of equipment is not sufficient by itself, so, as the authors suggest, for the infrastructure to be effectively used, digitally competent and supportive teachers in schools are essential.

A number of research studies considered potential gender differences between teachers in the use of ICT in class. Some studies showed that male teachers are more frequent users of ICT in their teaching and learning when compared to female teachers (Kay, 2006). Yet, in a study conducted by Norris, Sullivan, Poirot, and Soloway (2003), gender variable was not a predictor of ICT use and it's integration into teaching and learning.

3.2. ICT and Student Outcomes

In any study that aims to investigate the effect of ICT use on cognitive and affective outcomes, students are a key response group. However, they are rarely asked directly because of their limited ability to reflect on didactic issues and make self-assessments. Still, their opinions on whether ICT has made an effect on their learning and behaviour in educational activities provide interesting information about the effect of ICT from students' point of view. Furthermore, when investigating ICT's effect on learning outcomes, researchers often measure students' attainment using test scores in subject areas. So, they can make comparisons in attainment between classes in which students have low access and use of ICT and those in which students use ICT regularly.

3.2.1. ICT and Student Attainment

When considering ICT's effect on learning outcomes, it is important to have in mind that drawing conclusions from a variety of research results can sometimes be misleading. Different methodologies, sample sizes and education systems in different countries are just few of the

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many variables that could limit the measurement of direct causal impacts of ICT. Also, it has to be considered that many unobserved factors could influence the improvement of students' performance, such as school strategies and management, parents' attitude, teaching practice and the use of ICT. In a school with motivated teachers there is a higher possibility of ICT integration and better student achievement. Characteristics of the students, the technology, and their interaction can also influence the effectiveness of technology (Balanskat et al., 2006). Furthermore, Hennessy and Dunham (2002) stated that comparison between control and experimental groups using test scores is filled with difficulties, because complex factors are rarely accounted for (especially teacher behaviours and pedagogy). Therefore, it is almost impossible to entirely remove the effects of other factors and suggest a direct relationship between the use of ICT and attainment.

However, there are a number of repeatedly proven effects of ICT on learning outcomes. The Test Bed project (Underwood, 2006) investigated how stable use of ICT in teaching and learning can improve achievement outcomes for students. The findings revealed that schools which have a higher level of ICT equipment and integration into educational process demonstrate a more accelerated increase in student attainment than schools with lower levels. In participating schools, there was a significant improvement in achievement scores after only one year of ICT integration.

The e-learning Nordic study (Pedersen, 2006) is one of the many important studies that focused on perceived effects of ICT. It was conducted in Finland, Norway, Denmark and Sweden investigating teachers', students' and parents' opinions on consequences of ICT use in schools. The results revealed that a great majority of students, teachers and parents perceived a positive effect of ICT on students' learning, subject-related performance and their basic skills (reading, writing and calculation). A number of other studies report that teachers increasingly recognize the beneficial effect ICT has on students' performance in school (Kessel, 2005). ICT was proven to have positive effects on student attainment through developing data-handling skills, ICT-related skills, ability to construct complex models and understanding of the value of different ICT systems (Cox & Abbott, 2004).

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The use of ICT in education has been positively linked with improvement in several subject areas. In a research project, ImpaCT2, conducted by the British Educational Communication and Technology Agency (Harrison et al., 2002), there was a significant relationship found between the use of ICT and higher students' achievement. At age 11, most notable gain in achievement was found in English, at age 14 in science, and at age 16 in science, design and technology. The authors concluded that students in the 7-16 age range can have significant benefits in achievement in English, science and technology with the use of ICT. However, the authors mentioned that this may partly be due to the wider range of ICT resources available for these subjects.

Furthermore, the evaluation of the pilot project 'Embedding ICT in the Literacy and Numeracy Strategies' (Higgins et al., 2005) showed that students' performance significantly improved in English, mathematics and science tests, after only one year of integrating interactive whiteboards into teaching and learning, when compared with students in schools without interactive whiteboards. However, this finding was not sustained after the second year of implementation, so, it remained unclear if the effect on student performance in the first year of implementation is a result of good teaching methods or ICT alone.

Despite many positive findings reported in the literature, a number of recent studies and meta-analysis found that the integration of ICT and its effect on students' attainment still remains inconclusive and dissatisfactory (Pérez-Sanagustín et al., 2016).

a. Mathematics

A number of studies focused on the effects of ICT use on students' learning and performance in mathematics. Those are often small focused studies with defined specific outcome variables. Again, it is important to note that the authors of the studies have many times emphasized that they usually did not establish causal relationships.

Even back in 1993, researchers of the first ImpaCT project suggested that using a computer programming language (Logo), designed to aid the teaching of mathematics, significantly improved test scores in comparison with traditional methods. Mini-

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studies of the project showed positive effect of ICT on mathematical reasoning (Watson, 1993). The second, ImpaCT2 project (Harrison et al., 2002), also confirmed the positive effect of ICT on students' learning of mathematical skills. One of the important aspects of research in education is the generalizability of acquired skills. Au and Leung (1991) found that methodology in teaching Logo significantly increased the probability of generalizing mathematical skills to other context. Suomalo and Alajaaski (2002) further investigated the use of Logo and concluded that the most effective learning style were discovery-related methods, instead of teacher direction methods. In his paper, Clements (2000) summarized the main findings on Logo in teaching and learning process: when used appropriately, it can help students develop higher levels of mathematical thinking (especially geometric), learn geometric concepts and skills with teacher guidance (two-dimensional figures, angles, symmetry, congruence, geometric motions), learn to use algebra, develop concepts of ratio and proportion and form more generalised and abstract views of mathematical objects. Also, it can help students develop problem-solving skills, especially particular skills (e.g., problem decomposition, systematic trial and error) and higher metacognitive abilities, as well as enhance students' social interaction patterns.

When examining the influence on learning mathematics in a computerized environment, studies have shown that ICT can be an effective assistant in the development of mathematical reasoning, namely because they provide students with immediate feedback about their performance and progress (NCTM, 2000). Prompted by these findings, Kramarski and Zeichner (2001) examined the effects of two types of feedback (metacognitive and result feedback) on the ability to explain mathematical reasoning. It was found that students who received computerized metacognitive feedback explained their reasoning with a richer format. They also used verbal arguments and algebraic rules more often than students who were exposed to result feedback. The authors concluded that metacognitive feedback in a computerized environment can improve mathematical achievement and mathematical explanations, i.e. mathematical reasoning. They also believe that computerized metacognitive

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feedback sends a message to the students that their learning can be regulated by themselves.

Moreover, the OECD (2006) study found evidence of a significant relationship between the lenght of time students spent using the computer and their achievement scores in PISA mathematics tests. The authors of the study concluded that the longer students use computers (up to a certain point) the better scores they achieve in mathematics. The results showed that there is a significant difference in performance in mathematics between students who use computers for less than one year and those who use computers for more than five years. Again, the authors of the study emphasise that they do not suggest causal relationship, only significant interrelationships.

Furthermore, it has been found that the use of ICT can have a positive effect on graphical, and also programming skills. One of the most important advantages of ICT is the graphics and the potential to visualise data in real time. Friedler and McFarlane (1997) found that data logging (the process of collecting and analysing data with the use of computer) has a positive effect on graphical skills at 14 years of age. Regarding programming and it's effects, a significant contribution of programming tools in learning of mathematics in schools has been observed many times in different studies.

It should be noted that, in order for ICT to be integrated into mathematics teaching, it is necessary for teachers to have a solid understanding of ICT and familiarity with a range of applications ICT offers. The presence of ICT alone as a delivery system does not guarantee the development of students' skills and their achievement, however, when teachers use ICT in ways that challenge students' thinking and make them more active in investigations, students demonstrate a higher order of mathematical reasoning and increased attention (Cox & Webb, 2004).

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b. Science

According to Cox and Webb (2004), in both primary and secondary education the most extensive uses of ICT have been in science. In a number of research, positive effects of specific uses of ICT have been found on several student outcomes:

- understanding of science concepts,
- developing problem-solving skills,
- hypothesising scientific relationships and processes and
- improving scientific reasoning and explanations.

A meta-analysis (Christmann, Badgett, & Lucking, 1997) on ICT and attainment in secondary education revealed that students who received computer-assisted instruction had higher achievement than those who received only traditional instruction, with the strongest effects size for attainment in science. Also, as part of the ImpaCT2 study, Harrison et al. (2002) found that the frequency of students' ICT use had positive relationship with attainment in science. However, it was not familiar which types of ICT were used or their quality.

Based on the data collected from 2500 primary schools (Becta, 2001), a significant correlation was found between the score given for ICT resourcing and the science attainment score. Similarly, based on 409 secondary schools, significant differences were found between schools with good levels of ICT resources and those with low levels in science attainment. In another Becta report (Cox et al., 2003), a significant relationship between good use of ICT and student attainment in science was also found. However, the authors note that other possible and relevant factors were not controlled for.

Furthermore, Gillen, Lettleton, Twiner, Staarman, and Mercer (2008) investigated the use of interactive whiteboards in primary science education. Interactive whiteboards were used as instructional resources for facilitating the development of conceptual understanding in students. The results showed that the multimodal presentations on

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interactive whiteboards provided understanding and shared experiences for students, and also brought them closer to otherwise abstract scientific terms.

In contrast, some smaller studies found no differences between classes with varying levels of ICT use (Baggott La Velle, McFarlane, & Brawn, 2003) or between those using ICT or traditional approaches (Crosier, Cobb, & Wilson, 2000) in attainment in science. Moreover, some studies found negative effects of ICT use on science attainment. In some cases, the ICT was a distraction to learning science (Jarvis, Hargreaves, & Comber, 1997). For example, students sometimes took more time to learn how to use the software tool than it would take them to achieve the outcome without ICT (Davelsbergh, de Jong, & Ferguson-Hessler, 2000).

c. English

The relationship between the use of ICT in educational process and student attainment in English has also often been investigated in various studies. As Cox and Abbott (2004) stated in their paper, ICT use has contributed to some improvements in student attainment in English, however, the results of different studies are very inconsistent and restricted by the rate of ICT use and access in schools.

The first ImpaCT study (Watson, 1993) found positive effects of using word processing on students' attainment in English (measured by graded essays by two independent English teachers, by measures of cohesion and coherence in their texts and by number of errors in orthography) but only for students in the 8-10 age range (not for those in 12-14 age range). However, the frequency and duration were limited, and the authors concluded that any positive effects on attainment were difficult to find because of infrequent use of ICT in English classes. The second ImpaCT2 study (Harrison et al., 2002) also showed mixed results. There was a significant effect at the primary, but not the secondary level of education.

When taught as a first language, positive effects of ICT use in schools for attainment in English are found in different studies. The best results are found for primary school

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students, in the first stages of language development, and when the situation allows for students to compose and reflect on their work (Cox & Abbott, 2004). There are also important studies which show that ICT use has a positive effect on English attainment when English is taught as a foreign or additional language (Segers & Verhoeven, 2002).

Furthermore, a study conducted by the Department for Education and Skills (Higgins et al., 2005) provided results which suggest that the use of interactive whiteboards improved the achievement of students with low performance in English, especially in writing, while no other significant effect of ICT on student performance was found in the study.

However, as in any other subject, ICT's effect on students' attainment in English is greatly influenced by teachers' competence in using ICT. Mumtaz and Hammond (2002) state that, although word processing has been central for researchers in this area, it is not fully used in accordance with its potential. Namely, teachers mostly use it as desktop publishing tool or printer. The authors also found that young English teachers consider ICT essential for their profession, however, they did not feel completely prepared to use the potential of ICT. Their development as good ICT users is dependent on the context of their employment, mostly the support, encouragement and modelling that they receive (Cox & Abbott, 2004).

3.2.2. ICT and Students' Digital Competence

Students' capabilities to use digital technology have been seen as one of the key educational goals for the 21st century which demands understanding and monitoring of how well students master these complex and multifaceted competences in order to become proficient users. As previously elaborated, when describing what and how students acquire and learn with the use of technology, there are several concepts that share many similarities in defining those skills.

Siddiq et al. (2016) mentioned that there is a wide range of assessments of digital competence, from paper-pencil tests, multiple choice tests, questionnaires, to more performance based

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tests. Questionnaires that measure self-reports, in which students are asked to evaluate their skills in ICT-related tasks, have been used in majority of research studies. However, majority of studies found low correlations between students' self-reports and their actual performance (Ballantine, Larres, & Oyelere, 2007; Sink, Sink, Stob, & Taniguchi, 2008). Performance-based tests provide students with the opportunity to demonstrate their ability, generate their own responses, or create a product. Consequently, performance-based tests have the potential to measure students' digital competence more accurately (Siddiq et al., 2016).

Numerous studies indicated the diversity in students' digital competence with quite a wide variation in students' performance in digital competence (e.g. Calvani, Fini, Ranieri, & Picci, 2012; Hatlevik & Christophersen, 2013; Krumsvik, Ludvigsen, & Urke, 2011). In addition, the overall evidence on the effect of computer use on student digital competences has been mixed and inconsistent. For instance, longitudinal study "Monitor" which maps students' digital skills in Norway showed that time spent on computer use at home was positively related to digital literacy (Hatlevik et al., 2013). However, the use of ICT at school was negatively associated with digital competence score in a follow-up study (Hatlevik, Ottestad, & Throndsen, 2015).

As an application of the DigComp framework for cross-country EU-wide measurement of digital competence in the domain of learning, the study Survey of Schools: ICT in Education (European Commission, 2013) was conducted. This study involved the on-line surveying of headmasters, teachers and students at grades 4 (only teachers), 8, 11 and 11-vocational. Questions relating to digital skills and competence were directed to students by asking them to rate their level of confidence in their ability to perform a set of ICT related tasks. Though it has to be considered to what extent asking about confidence in skills is a true reflection of skills levels themselves, on average, students declared a fairly high level of confidence to use the Internet safely and responsibly, followed by their operational (content creation) skills and responsible use of the Internet (information) skills. Students were on average least confident in their social media (communication) skills. Large differences were found between countries in all the above areas. Across countries surveyed, students ICT use during lessons was far

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behind their use of ICT out of school, affecting their confidence in their digital competences. A key finding of the study shows that students who had high access to and use of ICT at school and at home reported higher confidence in their operational ICT skills, in their use of social media and in their ability to use the Internet safely and responsibly, compared to students who reported low access and use at school but high access and use at home. The student profile characterised by high access/use at school and at home is defined as the digitally confident and supportive student. On average, between 30-35% of students were found to be digitally confident and supportive students. Besides highest levels of confidence in their digital skills, this profile was associated with the highest frequencies of ICT based activities at school, with the most positive opinions about ICT use in teaching and learning and with the most favourable attitudes towards computers (European Commission, 2013).

However, in Croatia (European Commission, 2012), it was found that students' confidence in their operational skills is significantly lower than the EU mean at grades 8 and 11 vocational (grade 11 general was placed in the middle group of countries). Also, at all grades in Croatia, students' confidence in their social media competence is in line with the EU mean (except for grade 11 general where it is notably lower). Regarding students' confidence to use the Internet safely and responsibly, Croatia is mostly in the bottom group of countries (grades 8 and 11 vocational) and in the middle group of countries (grade 11 general). The results obtained on a European level are supported by a study conducted in Croatian schools (Mohorić, Kolić-Vehovec, Rončević Zubković, Kalebić Maglica, & Takšić, 2016), where majority of students reported they felt the most competent in using the Internet safely and responsibly, and less competent in other dimensions. Students felt the least competent in their social media skills. Moreover, secondary school students reported higher scores in all dimensions (using the Internet safely and responsibly, social media skills, operational and problem solving skills), compared with primary school students.

Further valuable insights regarding the extent to which students had developed digital competences to support their capacity to participate in the digital age were provided by the International Computer and Information Literacy Study (ICILS 2013) (Ainley, Fraillon, Schulz, &

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Gebhardt, 2016). This study was conducted under the aegis of the International Association for the Evaluation of Educational Achievement in 20 education systems during 2013. Data on computer and information literacy were gathered from almost 60,000 grade 8 students in more than 3,300 schools from 21 countries, including Croatia.

Within the ICILS 2013, computer and information literacy construct was articulated as part of an assessment framework (Fraillon et al., 2013), as well as operationalized in an assessment instrument. The computer and information literacy construct combines information literacy, critical thinking, technical skills and communication skills applied across a range of contexts and for a range of purposes. Specifically, the construct was conceptualized in terms of two strands of the framework. *Collecting and managing information* is focused on the receptive and organizational elements of information processing and management and includes knowing about and understanding computer use, accessing and evaluating information and managing information. *Producing and exchanging information* is focused on using computers as productive tools for thinking, creating, and communicating and includes transforming information, creating information, sharing information and using information safely and securely. The assessment was computer-based and included a combination of simulated and authentic software applications, multiple choice and text response items, designed to reflect students' typical "real world" use of ICT in school-based and out-of-school-based contexts. The developed instrument allows the description of students competences in terms of four levels of proficiency. The obtained results indicated that there are considerable variations in students computer and information literacy across countries. The majority of students (81%) achieved scores that placed them within Levels 1, 2, and 3. In Croatia, the highest percentage of students was recorded for those performing at Level 2 wich was also the case in all but two of the other countries that participated in the study. The variations in computer and information literacy proficiency show that while some of the students participating in ICILS were independent and critical users of ICT, there were many who were not (Ainley et al., 2016). Students scores on the applied authentic computer-based tasks were moderately associated with their own ratings of their capacity to use computer technology. In addition, the ICILS results showed that students' experience with computers, as well as regular home-

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based use of computers, had significant positive effects on computer and information literacy, even after controlling for the influence of personal and social context. However, variations in computer and information literacy across countries, despite the high levels of access to ICT and high levels of use of these technologies by students in and (especially) outside school, suggest that the devolopment of students' capacity to use digital technology should be supported by coherent learning programs (Ainley et al., 2016). In this context, school-level planning should focus on increasing teacher expertise in ICT use.

These and many other findings in the existing literature suggest that digital inclusion does not occur automatically, and therefore, this is an issue schools and teachers have to work with (Erstad, 2010). Recent analytical report by the OECD (OECD, 2015a) suggests that effect of technology in education remains sub-optimal. Based on the comparative analysis of the digital skills acquired by students in 64 countries, it was suggested that basic ICT skills may not add value unless they are well paired with cognitive skills and other skills, such as creativity, communication skills, team work and perseverance.

3.2.3. ICT and Students' Motivation, Attitudes and Skills

Majority of conducted studies that investigated the effect of ICT on students did not rely solely on measures of student attainment, but also on indirect variables such as motivation, attitudes, reading comprehension, writing, thinking and social skills. Many published papers confirm ICT's positive effects on those variables (Balanskat et al., 2006).

a. Motivation and Attitudes

Numerous papers report on enhanced motivation and attitudes toward learning in ICT-supported schools, however, many of the results in those studies are obtained by using interviews, observations and questionnaires. So, there is still a need for more research to use established attitude tests (Cox & Abbott, 2004).

In many research it was reported that, since ICT implementation, students increased their commitment to learning, stayed longer on tasks and achieved more through the

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use of ICT (Cox & Abbott, 2004). The Eurobarometer Benchmarking survey (Korte & Hüsing, 2006), conducted on a wide European level, revealed that a great majority of teachers (86%) believe that students are more motivated and attentive in class, since they use computers and the Internet. Also, many studies have provided evidence that students' motivation and engagement significantly increased since using mobile devices in class, in both primary and secondary schools (Berson, Berson, & Manfra, 2012; Murray & Olcese, 2011).

The results from the ICT Test Bed Project (Underwood, 2006) and the e-learning Nordic study (Pedersen, 2006) also supported the finding that ICT has a strong motivational effect on students' motivation and engagement, resulting in greater persistence and a more profound understanding among students. In the Nordic study, teachers reported that students participate more actively in class since they started using ICT. Furthermore, teachers believe that when students use ICT for group work, their motivation and collaboration significantly increase. Students also think that they pay more attention during class and that they are more motivated, because they feel ICT is making their schoolwork more enjoyable and different from traditional education. The authors conclude that students' attitudes and motivation for learning activities change when they start using ICT in class.

Furthermore, in a study conducted in Croatian schools (Center for Applied Psychology, 2015b) it was found that students percieved more benefits of using ICT at home, when compared with perceived risks. However, when considering ICT use in the context of teaching and learning, students equally perceived benefits and risks. Moreover, secondary school students perceived more benefits, as well as risks, in comparison with primary school students.

In a case study conducted in two Croatian primary schools (Kolić-Vehovec et al., 2015) it was found that students who use tablet PCs in class and those who don't perceived both positive and negative aspects of ICT use. However, users of tablet PC had more positive and less negative attitudes.

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A study conducted by Passey, Rogers, Machell, McHigh, and Allaway (2003) in case study schools, all of which were chosen as exemplars of good ICT practice, showed that in general the motivational effect of ICT was positive. Naturally, the outcomes were affected by the circumstances and ways in which ICT was used. The study identified positive motivational effect of ICT use on several learning processes: engagement, research, writing and editing, and presentation. According to the the authors of the study, students reported that the types of ICT they found especially useful were: the Internet, interactive whiteboards, writing and publishing software and presentational software. Also, the study provided evidence of ICT's positive effect on students' attitudes towards ICT and engagement with their schoolwork. Moreover, some students and school staff reported better behaviour in class since ICT was used. From the conducted interviews with primary and secondary school teachers, the authors concluded that ICT had a positive effect on students' interest and attitudes towards their schoolwork, their engagement in learning activities and their time management. Students were more responsive to teachers and other students, and they worked more independently. As a result, teachers felt that students were learning more. Students also reported that ICT made lessons more interesting through using the Internet, experimenting and having the opportunity to better express themselves. Likewise, teachers reported that ICT helped students take pride in their work, supported their research and made it more probable that tasks would be completed on time. However, some teachers felt that sometimes, regardless of students' stimulated interest, content of learning was not improved. Some students reported that they were frustrated when the ICT equipment went wrong, meaning that their interest depended upon the functionality and reliability of the technology. The authors of the study concluded that ICT improved motivation and consequently influenced the quality of students' work. However, ICT should be used to support subject learning, instead of just addressing issues related to engagement and presentation of work, in order to fully achieve desired outcomes.

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b. Learning Skills

For the learning to be successful, it is required that students develop certain skills. Reading, writing and thinking skills involve both cognitive and metacognitive skills. They are fundamental for learning more complex skills, such as planning, organising, monitoring and assessing one's own competencies. ICT can play an important role in developing the learning skills much needed for later education.

Most research dealing with ICT and *reading* are focused on specific skills, especially those that can be readily assessed (e.g. phonological awareness, word recognition). Although significant gains in those skills were sometimes found, the authors often stated that this does not mean that this level of achievement is higher than what would be expected from a group taught by an experienced teacher. Also, papers investigating ICT in the field of reading is mostly concentrated on helping children and disabled readers to acquire reading skills, and on different ways the text itself might be presented to aid instruction. Meta-analytic studies showed that few research found significant results, but that the results are not always positive (Hartley, 2007).

With regard to *writing skills*, as stated by Hartley (2007), there are two streams of opinion. Some researchers believe that ICT liberates people from many problems that occur when writing by hand (e.g. letter formation and alignment), and that it also facilitates rewriting, editing and spelling. Released from this difficulties, people have more time to think about the content. However, although other researchers also agree that ICT facilitates the skills of writing, they think that this does not automatically change the quality of the finished product. A meta-analysis conducted by Goldberg, Russell and Cook (2003) concentrated on 26 high-quality studies, which investigated whether or not new technology changed writing skills of children. The authors of the study concluded that, on average, students who use computers in learning to write are more motivated and engaged in their writing, and they also produce texts of higher quality and of greater length.

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The ICT Impact Report (Balanskat et al., 2006) reveals that most teachers experience a moderate or high degree of positive effect of ICT on writing skills. Students also support this finding, however, they are more critical and expressed a divided opinion in some countries (Finland, Denmark). These findings are supported by the results from the e-learning Nordic study (Pedersen, 2006), where 52% of students reported that ICT increased their performance in school subjects, and their opinion was supported by 83% of teachers. The results of the study show that both reading and writing levels were higher than it was the case for students who did not use ICT. The qualitative analysis also reveals that text production increased, consequently improving students' competence in writing, argumentation and reflection skills.

Furthermore, ICT has been used with intention to develop the *thinking skills* of young children. The idea that children could learn more effectively by teaching others provides support to a constructivist model of instruction. It also suggests that learning in groups results in development of cognitive learning in students, and ICT provides many opportunities for such learning (Hartley, 2007).

c. Social Skills

Learning is often a social activity as well as a cognitive one, therefore, social skills are also developed through the process of learning. It was found that the use of technology can help extend traditional work on learning in pairs and in small groups (Hartley, 2007). Lou, Abrami, and d'Apollonia (2001) conducted a meta-analysis covering 122 different studies that compared individual with group learning with the use of ICT. The authors concluded that, despite some differences between groups, learning in pairs proved to be more effective than individual learning, and also, that bigger groups (3-5 members) performed better than pairs.

Interactive whiteboards can have a significant influence on social activities in class because they offer many opportunities for group work and collaboration. With the use of interactive whiteboards, students work with the whole class, instead of individually

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or in pairs while sharing a computer (Hartley, 2007). Clemens, Moore, and Nelson (2001) investigated problem solving and reasoning by comparing two parallel classes with students from impoverished backgrounds and with low pretest achievements in communication. One class was taught with the use of interactive whiteboard, and the other one without it. Results show that students who had classes with an interactive whiteboard achieved considerable advancement from pretest to posttest measurement, compared with the significantly lower posttest scores achieved by the control group. Also, the authors reported that students with the interactive whiteboard responded enthusiastically to the new method. Similar finding is reported in a study by Wall, Higgins, and Smith (2005), where students expressed great learning and social benefits from the use of interactive whiteboards.

d. Individualised Learning

Although learning in groups is stimulating for students' learning process, their individual needs can sometimes require individualised teaching. Among the most important benefits of ICT is the fact that it enhances a more personalized teaching. As stated in the e-learning Nordic study (Pedersen, 2006), ICT allows for greater differentiation, particularly in primary schools, with programmes personalized for students' individual needs. Majority of teachers that participated in the study felt that ICT provides them with the opportunity to create various learning tasks within the same classroom, for the benefit of the individual students. Also according to teachers, students work more in cohesion with their own learning preferences, which results in a positive effect on both academically strong and weak students. Furthermore, students, as well as their parents, expressed that they solve assignments more on their own way when using a computer.

In the Norwegian pilot study (Network for IT-Research and Competence in Education, 2004) it was revealed that students work more independently and effectively when they use ICT, and that they take greater responsibility for their own learning. By receiving individualised assignments appropriate for their level of study and by having

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greater insight into teachers' goals, students are more able to work at their own rate. Students believe that ICT provides tasks more suitable for their individual needs and facilitates organizing their own learning. The authors conclude that these diverse learning situations help students develop a variety of skills and work techniques, as well as confidence in their own ability to learn, consequently having an effect on their performance in school subjects.

Furthermore, according to the UNESCO study (2006), ICT facilitates learning for students who have different learning styles and abilities, including slow learners, the mentally and physically handicapped, gifted students, the socially disadvantaged, and students living in remote learning areas.

3.2.4. Benefits of ICT Use for Students with Special Needs

Although ICTs have for some decades been available in many schools in countries around the world, most studies on using ICT in education have focused on children without disabilities (Samuelsson, 2010). Several studies have shown that children with disabilities and special educational needs have restricted participation in school activities, compared to children without disabilities (Desch & Gaebler-Spira, 2008; Söderström, 2009). When it comes to ICTs' potential to enhance the participation of children with physical disabilities (e.g. acquired brain injury, cerebral palsy), visual (low vision, blind), hearing (deaf, hearing loss) or speech (communication) impairment, empirical research is scarce.

However, in some studies it has been recognised that ICT has a great potential for increasing the inclusion of people with disabilities in different educational activities (Cox & Abbott, 2004). The literature has emphasised that children with special educational needs can greatly benefit from using technology in their education and that ICT could enable those students to participate more fully in everyday school activities. Nonetheless, dedicated efforts should be made to make sure that already disadvantaged and marginalized groups are able to acquire and develop the necessary digital and other key competences via ICT for participation in society. ICT-enabled learning can offer new opportunities to those who encountered obstacles

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at learning and performing at school, and to those who could not benefit from traditional obligatory education (Punie et al., 2006).

As reported by Lewis and Neill (2001), main functions of ICT support in the context of special needs are: interaction communication, physical control and access to the normal curriculum, subject-linked learning, reward/motivation, information technology skills, assessment, record-keeping and teacher support. It has been found that technology can increase autonomy, improve communication and promote inclusion and confidence in children with special needs. Typing notes and messages using ICT is usually easier and less time consuming than writing by hand, which is facilitating for children with different disabilities who struggle with their handwriting. Also, for children with reading and writing difficulties, a software transporting text to speech and vice versa, as well as spelling checks, have proved to be very successful. In addition, all the educational materials can easily be stored and reviewed later on (Clarke & Svanaes, 2012).

According to The ICT Impact Report (Balanskat et al., 2006), students with special educational needs or bihevoural difficulties greatly benefit from the use of ICT. It can significantly support their motivation and concentration. Also, the study showed that only by sitting next to the student working on the computer teachers become more informed and aware of individual student's special needs and problems.

A systematic review of literature regarding ICT-supported learning for people with special needs (Istenic Starcic & Bagon, 2014) was based on studies investigating the benefits of ICT for students with special needs. Those benefits are related to:

- increasing participation,
- providing social and emotional support,
- facilitating inclusion and access to a mainstream curriculum, and
- connecting them to otherwise inaccessible social contexts.

As Lindstrom and Hemmingson (2014) stated in their literature review, ICT facilitates students' quality of writing, decreases spelling errors and increases accuracy and writing speed for

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students who have a mild motor impairment with handwriting difficulties. This outcome has very positive implications, since writing is an important activity in school, and a prerequisite for participation in other activities. The authors also stressed the importance of conditions in the environment which are crucial in terms of whether the outcome of ICT use was successful. Some of those beneficial conditions were access to computer and software, teachers' competence in the use of word-prediction programs and students' increased motivation for writing.

Studies that evaluate ICT use for children with special needs often aimed to investigate the effects and benefits for students and teachers in language learning and mathematics. Even back in 1991, a study was conducted with a goal to investigate mathematical learning for children with severe learning difficulties (McEvoy & McConkey, 1991). As a part of the study, teachers received a video self-instructional course about new methods used in the classroom with the help of ICT. When teachers tested those methods in the classroom, it has been noted that they had a significant effect on students' progress. Istenic Starcic and Bagon (2014) specify several tools which have been found to help students with special needs in language learning and mathematics. *Wordshark* is a multisensory drill and practice program for improving spelling and word recognition. The program is widely used in primary and secondary education with students who have special needs, improving their skills and facilitating their motivation (Singleton & Simmons, 2001). *SignMT* is a second language learning tool that was evaluated and proven to satisfy the needs of the hearing-impaired and deaf users (Ditcharoen, Naruedomkul, & Cercone, 2010). Predictive text entry significantly increased the quality of written work and reduced spelling errors of children with speech impairment and poor motor control.

Furthermore, a number of studies have shown that the use of ICT-supported learning and collaboration has a positive influence on peer acceptance and socio-emotional support among children with special educational needs (Magnan & Ecalle, 2006; Tan & Cheung, 2008; Shamir & Shlafer, 2011).

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It is however important to note that, while ICT can facilitate equal engagement of students with disabilities, it cannot substitute the quality of teaching and learning methods with regard to providing differentiated instruction, developing competence in ICT use and providing opportunities for creative expression (Istenic Starcic & Bagon, 2014).

Countries around the world put different amounts of effort into developing ICT-supported educational activities for students with special needs. The International Experiences with Technology in Education study (Bakia et al., 2011), investigating primary and secondary level education in 21 countries, showed that there are not many uses of ICT to support special-needs students at the national level in participating countries. Although eighteen countries expressed interest in using ICT to provide better learning opportunities for students' individual needs, only thirteen countries have developed such programs, which means that this is an emerging area and that efforts are possibly already underway. It is also important to note one exception, Belgium, which launched its ICT Without Boundaries program in 2007 in order to improve opportunities for children with special educational needs. The programs' primary focus is developing learning materials for those students, including students with hearing and mental disabilities, and those with autism spectrum disabilities. Also, the program has an e-mail client for mentally disabled children, and a remote access for children who can't leave their home. Among the countries surveyed, one of the common ways to individualize instruction is on-line tutoring. For students with special needs, on-line tutoring can provide additional help in an individualised way. It facilitates tracking their responses and focusing on the areas where they need support the most, and moreover, it provides children with special needs with experiences they would not have in the traditional school.

Conducted studies, especially those published before the year 2000., mainly investigate ICT-supported learning with regard to particular disability groups. Only a few recent papers address universal design, including all students. Principles of universal design can make a significant contribution to the support of inclusion processes, providing accessibility of resources and processes for all students. Studies investigating ICT supported learning should address all students, those with special needs and those who do not have special needs,

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considering universally designed studies that include solutions for special requirements can be beneficial for all users (Istenic Starcic & Bagon, 2014). Examples that have been proven to be beneficial for all students include instructional design solutions for students with learning difficulties (guided instruction, learning strategy support, supplementary learning material, varying test formats) (Silver, Bourke, & Strehorn, 1998).

a. **Advantages of Tablet Use for Children with Special Needs**

Although most of the benefits for children with disabilities can be achieved through other technology, the use of one-to-one tablet device has been shown to be particularly beneficial for those children (Clarke & Svanaes, 2012).

It has been found that children with special educational needs greatly benefit from multi-sensory technology. Tablet devices are multi-sensory and multi-touch, and, compared to other assistive technologies, they are also more cost-effective, light and durable. An important attribute for many children with special needs is that tablets allow instant response and instant cause and effect. Students who would usually struggle with homework, lesson material and messages from teachers could now store and access all the materials and information in one place, and have everything sent to them by e-mail. Also, e-mail communication between students with disabilities and teachers made it more accessible to keep parents informed of their childs' progress and assignments (Clarke & Svanaes, 2012).

Moreover, for students with learning difficulties the tablet can offer simple visual, non-linear ways of organising their material, such as mind-mapping applications. Mind mapping is just one of the ways in which tablets remove students' obstacles to accessing content and communicating and demonstrating their work (Clarke & Svanaes, 2012).

Also according to Clarke and Svanaes, (2012), all tablet school teachers reported that children with special educational needs felt sense of pride and increased self-esteem because they were using and working on the same device as others. Using the same

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device as other students and being more independent has shown to increase confidence and wellbeing among many students with disabilities.

3.2.5. Moderators of the Relationship between ICT Use and Student Outcomes

It was emphasised multiple times in this chapter that the significant outcomes found in various studies do not prove the existence of a direct causal link between the use of ICT and student achievement. Here we report on just some of the many possible moderators that could influence the relationship between ICT use and student outcomes.

a. Age

When integrating ICT into teaching and learning, it is important for the resources to be age-appropriate, and for students in different age groups to have different levels of access to ICT. Such differences could mediate apparently different achievements in students, although age itself is probably not a relevant moderator of the effect of ICT on attainment (Cox & Abbott, 2004). In a study conducted by Clarke and Svanaes (2012) it was concluded that younger and older students differ in the use of tablet in school. Teachers reported that, compared with younger students, it was much harder for older students to accept and use tablet as a learning tool, as opposed to using it primarily as a gaming tool. It was also stated that older students are more resistant to change and less adept at implementing tablets in their learning.

b. Gender

Gender differences are also frequently considered important when implementing ICT in schools. Several studies investigated the relationship between gender and technology experience and attitudes. It was found that boys use the Internet more frequently than girls (Nachmias, Mioduser, & Shemla, 2000; Pregrad et al., 2010, Salmela-Aro, Upadyaya, Hakkarainen, Lonka, & Alho, 2016). Also, boys are more likely to have higher experience with technology than girls (MacCallum, 2009). Cooper

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(2006) suggested in his paper that the source of the differences between boys and girls comes from anxiety when students interact with technology. He also stated that girls are at a disadvantage relative to boys when it comes to learning with technology in school, because of their lack of experience. So, it can be argued that if technology experience is increased, anxiety towards technology use could be reduced.

c. Motivational Orientation

When implementing ICT into teaching and learning it is also important to have in mind that students differ in their motivational orientation. Laakso and Hannula (2010) stated in their paper that students' motivation in ICT depends on their motivational orientations. Students who are performance-avoidance oriented may find relief in such environment, because it allows them to focus on the assignment without worrying about social cues. Also, students' who are performance oriented might experience technological environment as threatening, because it is unfamiliar, and they could consequently develop performance-avoidance behavior (Järvelä & Niemivirta, 1999).

d. Background

Whether students come from urban or rural background is also something that has been found to play a significant role when investigating students' performance and ICT use. Kantabutra and Tang (2006) conducted a study in Thailand and found that students in rural schools had lower academic achievement than students from urban schools, as a result of differences in access and use of ICT in schools. Another study (Ferrer, Belvís, & Pàmies, 2011), conducted in Spain, revealed that students with better access and exposure to technology, and also with prior knowledge about technology, experienced less frustration and errors in their problem solving. Also, students who have lower access and use of technology are more likely to achieve lower academic scores (Mutula, 2005). Furthermore, Pruet, Ang, and Farzin (2016) found that rural students experienced higher anxiety and less tablet acceptance than students with

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urban backgrounds. The authors suggested that this can be explained by the fact that students from rural areas had less experience with ICT use that students from urban areas.

e. Teachers' Pedagogies

According to Kirkwood and Price (2015), in various projects the expected outcomes of ICT use were not always appropriate for the type of intervention being made. It is very important to emphasise that simply changing the delivery method does not significantly alter the pedagogic function. In order for ICT to have any meaningful effect on students, it is essential for teachers to use technology in constructive ways. Teachers' approach to teaching and learning (transmissive, constructivist, collaborative, etc.) will be reflected in the manner in which ICT is used for learning activities. Accordingly, when describing technology innovation, it is important to specify and explore the educational purpose and mode of deployment.

Wong, Kamariah, and Tang (2006) found that, in schools in which teachers practice a more student-centred pedagogical approach, teachers tend to value inquiry and collaborative learning. Also, they perceive that ICT played an important role in the transformation of teaching and learning by providing useful resources for designing student-centred activities. The authors stated that two models of innovative pedagogical practices mediated through ICT have turned up from the results: a balanced model and a pedagogically driven model. In order to make pedagogical innovations happen, teachers should move away from a teacher-centred approach to one that is more student-centred. ICT provides a range of opportunities for exploratory activities designed by teachers, and also assists students in constructing their knowledge collaboratively and expressing their ideas. In contrast, mere technological innovations, without the change in teachers' pedagogical practice, are not enough to cause innovative classroom practices with ICT.

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Teachers can use ICT for teaching traditional methods (e.g. using interactive whiteboards for presenting content in traditional way) or they can use ICT to support important changes in teaching and learning (e.g. using interactive whiteboards where students present their work). According to many researchers, the most effective ways of using ICT are those that challenge students (Cox & Webb, 2004).

Cox and Webb (2004) also reported in their paper a list of ICT pedagogies which influence students' attainment:

- teachers' decision to take up the use of ICT in their teaching;
- types of ICT resources they choose;
- teachers' knowledge about their subject;
- their knowledge of the benefits on students' learning that ICT provides;
- their digital competence;
- planning and organising for lessons;
- teachers' ability to integrate ICT into their whole curriculum programme;
- understanding that ICT can promote new kinds of learning and knowledge;
- their ability to relate the ICT activity to learning objectives and
- ability to measure relevant learning outcomes.

The authors also suggested that when teachers use their subject knowledge and stimulate students' understanding of the subject, they use ICT in more effective ways. When students are challenged to think and to question their own understanding, the effect of ICT on their performance is the greatest.

f. Curriculum

Savelsbergh et al. (2016) mention that one of the key problems in investigating ICT's effect on student outcomes is that studies often compare student outcomes without accounting for the ways in which the curricula differ. Whether ICT is just added into a traditional curriculum or the curriculum is at least partially shaped by the ICT is an important factor when drawing conclusions on the effect of ICT on student

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performance. The type of ICT utilization at the school level is essential since the use of ICT in a fully traditional curriculum is not expected to have a significant effect on the learning outcomes (Biagi & Loi, 2012).

g. The Frequency and Purpose of Students' ICT Use

The frequency of students' use of ICT at school or at home, as well as the purpose with which they use ICT, can also play an important role in achieving desired outcomes in students with the use of ICT. A worlwide study (OECD, 2011) gave a detailed report on the relationship between the frequency and purpose of students' ICT use and their level of digital reading performace, so in this section the results of the study are described thoroughly.

According to the results, the relationship between digital reading performance and the frequency of computer use at home for leisure or for schoolwork was not linear. Both rare and intensive users achieved lower scores in digital reading than moderate users. When accounting for students' academic abilities, the frequency of computer use at home, especially computer use for leisure, was positively associated with navigation skills and digital reading performance, however, the computer use at school was not. Based on the results, the authors of the study suggested that students are mainly developing digital reading literacy by using computers at home for their personal interests (OECD, 2011).

A finding suggesting that students who have a computer at home tend to perform better than students who have no computer at home was obtained in all 19 participating countries. However, in most countries students without a computer at home are usually those from socio-economically disadvantaged backgrounds. Indeed, after accounting for students' socio-economic background, the performance advantage among students who use a computer at home tended to be smaller in all countries. In Korea, Austria and Sweden, students who do and those who do not have access to computers at home performed similarly. Still, in most participating countries,

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students who use a computer at home performed better than those who do not, even after accounting for students' socio-economic backgrounds (OECD, 2011).

Regarding computers per student ratio and performance in school, no consistent pattern was observed across countries. In Austria, Chile and Colombia, in schools where there is an above-average ratio, students tended to perform better than students in schools with a below-average ratio. However, in Korea, Hungary, Japan, Poland, Iceland and Hong Kong-China, students in schools with a below-average computers per student ratio in schools performed better than students in schools with an above-average ratio. There were no performance differences found between the two groups of students in the remaining participating countries. It was of course difficult to establish a causal nature of the observed relationships, as it might have resulted from the influence of third factors. However, there was no performance difference in digital reading found between students in schools with below or above-average computers to student ratio in almost all countries, after accounting for the socio-economic background of students in schools (OECD, 2011).

Also, when the authors investigated the performance difference between students who reported using computers at school and students who reported that they don't use computers or have no access to computers at school, different results were found across countries. In seven countries there was no performance difference in digital reading between these two groups of students, but in eight countries (Sweden, Australia, Norway, New Zealand, Iceland, Japan, Belgium and Spain) students who use computers at school achieved better results than those who do not use computers at school. Also, in two countries (Hungary and Poland) students who do not use computers at home performed better that those who do. The socio-economic backgrounds of schools are in many countries not related to whether students use or do not use computers at school. The performance differences between the two groups remained even after accounting for socio-economic backgrounds of students and schools in all participating countries (except in Poland) (OECD, 2011).

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Furthermore, when investigating computer use at home to play collaborative on-line games, students who never or hardly never use a computer for that purpose achieved the highest scores in digital reading, followed by students who use a computer at home to play such games once or twice a month. Compared with other students, those who use a computer for that purpose at least once a week achieved the lowest scores (OECD, 2011).

As was the case with students' use of computers at home for leisure, the relationship between students' use of computer at home for schoolwork and performance in digital reading was not linear, suggesting that students who use computers at home for schoolwork at a moderate level tend to perform better than both rare and intensive users. This finding was obtained in almost every participating country. There was no country in which those students who rarely use computers at home for schoolwork performed better than moderate or intensive users, and in most cases, intensive users achieved the same or lower scores than moderate users and the same or better results as rare users (OECD, 2011).

Across all participating countries, students who moderately use computers at school achieved slightly better results in digital reading than rare users, and both groups achieved better results than intensive users at school. Again, regarding relationship between the index of computer use at home and performance in digital reading and three PISA assessment areas (print reading, mathematics and science), the study findings suggest that moderate users tend to perform better than rare and intensive users (OECD, 2011).

Among the students in participating countries with above-average performance, students who use computers at home almost every day to play collaborative on-line games visited an average of about one-half page more of relevant text than infrequent users did. Also, when considering students with above-average performance, students who browse the Internet at home for fun visited two additional relevant pages

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compared with students who hardly ever use computer at home for that purpose (OECD, 2011).

The authors of the OECD study suggest that there is no significant positive relationship between using computers for schoolwork and developing navigation skills. They offered a possible explanation suggesting students who use computers frequently for schoolwork might just be following instructions and might not have much opportunity to personally search for information. However, in almost all participating countries, using a computer at home was found to be related to digital performance, even after accounting for students' socio-economic background, but it also varied across countries. The pattern of the relationship differed mostly according to where the computer is used (at home or at school). Again, regarding computer use at home, performance grew from rare to moderate users then dropped from moderate to intensive users. However, in contrast, the relationship between students' use of computer at school and performance in digital reading was negative. Authors explain that students who intensively use computers at school may need additional tasks to catch up to other students or may require more time to complete their studies (OECD, 2011).

Furthermore, there was a positive linear relationship found between performance in digital reading and computer use at home, especially computer use for leisure, but no significant relationship was found for computer use at school. Also, computer use at home was found to be related to navigation skills, which is an essential part of digital reading. These findings indicate that students mainly develop their digital reading literacy by using computers at home for their personal interests. Students' use of a computer at home has proven to be an important factor across all participating countries when it comes to students' attainment. After taking students' proficiency in print reading into account, home computer use still remained an important aspect that affects digital reading performance. This indicates that students' use of computers at home is related to better digital performance and, moreover, it explains the

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performance difference between print and digital reading. For example, if two students who share a similar level of print reading proficiency (and have similar characteristics in other important aspects) are compared, the student who uses a computer at home will probably achieve a better result in digital reading than the student who does not use a computer at home. Based on the study's results, another important factor in explaining the difference in performance between print and digital reading was the index of on-line social activities and the index of on-line searching-information activities. Students who engage in more on-line social activities and searching-information activities tended to achieve better results than students who do not, regardless of their potential similarity in print reading proficiency (OECD, 2011).

Occasionally negative relationship between students' computer use at home and digital reading performance can result from variations in how digital technologies have (or have not) been integrated into curricula and instructional systems, or from making computer usage at school a more common experience for students with lower levels of academic performance. Some of the important indications from these findings are that access to computers at school does not solely determine student performance, and that it is essential for students who use computers at school to develop the knowledge and skills needed to use the range of information and resources the computer provides (OECD, 2011).

3.3. ICT and Teacher Outcomes

Implementation and integration of ICT into educational process necessarily requires teachers' support, cooperation and commitment. When investigating the effect of ICT use in schools, teachers are, together with students, a key respondent group. Research aiming to identify ICT's effect on teachers are mostly focused on the potential change in their teaching pedagogy, but also on drawing attention on the issues that require more consideration. We review main findings of studies that investigate the effect of ICT on teachers' work efficiency, their teaching practice, digital competence and their perceptions and attitudes.

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3.3.1. ICT and Teacher Efficiency

It was found in numerous studies that ICT can help teachers in organising and planning their work and classroom activities. A study conducted by UNESCO (2006) investigated how ICT potentially offers advantages and opportunities for students and teachers. They concluded that ICT enables teachers to save time and increase productivity in many educational activities. Those activities include:

- preparing for lessons and updating them daily,
- making plans, including individualised educational plans for students with special educational needs,
- making visualisations and handouts for classes,
- presenting a variety of content materials, assignments and questions for the class,
- maintaining class and grade books,
- compiling exam questions,
- on-line assessment and feedback on students' work, and
- keeping records and archives of all proceedings with easy access and use.

Furthermore, Underwood et al. (2005) found that the introduction of broadband Internet in schools has helped teachers to become more productive, improved the collaboration among teachers, and helped them to reduce workload. A number of other studies provided evidence that daily use of ICT in teaching and learning increases teachers' efficiency in planning and preparation of work. In some studies, teachers report about the lack of time to integrate ICT, however, many studies have shown that ICT integration can save considerable time in medium and long term planning. These results suggest that teachers need to be instructed on how ICT, if efficiently used, can save time (Underwood, 2006).

3.3.2. ICT and Teaching Practice

In accordance with the changes in the educational process, teachers are more and more expected to be critical dialogue partners, advisors and leaders for specific subject domains

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(Network for IT-Research and Competence in Education, 2004). When considering the role of ICT in those changes, it is believed that the most successful ICT use in teaching and learning includes a shift through different teacher-student interaction. Using ICT in class necessarily implies new teacher roles, new pedagogies and new approaches to teacher education.

Using technology in education is not easy for most teachers, since it often implies organizational change and changes in the way educational content is offered to students. These changes require teachers to adopt new teaching and learning practices. The success of ICT integration into educational practice strongly depends on the ability of teachers to design learning environments in new ways, to merge ICT with a new pedagogy and to develop socially active environment, encouraging group work and collaborative learning (Hine, 2011). ICT integration and the degree of effect it may have is largely determined by the pedagogical practice, mainly because it can influence teachers' use and, consequently, students' attainment (Cox et al., 2003).

Cox and Abbott (2004) supported the notion that the way in which the ICT is used is a crucial variable that moderates the relationship between ICT and student attainment. Teacher pedagogies are probably the most important determinant of the effectiveness of ICT use in education because they influence the selection of ICT resources, ways of using ICT, preparation of lessons, level of ICT integration in the subject, etc. Naturally, when the way of using ICT is appropriate and relevant to the learning objectives and teaching and learning purposes, the effects of ICT on performance are the strongest.

The E-learning Nordic study (Pedersen, 2006) also provided evidence to support the conclusion that the effect of ICT is highly dependent on how it is used. Different teachers see the biggest effect of ICT in diverse educational situations. While some teachers see the greatest benefits in using ICT to create a physical product, others feel that ICT's most important attribute is supporting group and project work. Specific ICT uses are therefore dependant on the school culture and the personal opinions of teachers.

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Teachers can use ICT to enhance teaching in various ways, from using ICT as a tool to support traditional methods to using ICT to support completely new, different teaching methods (Punie et al., 2006). As stated by the author of The ICT Test Bed evaluation (Underwood, 2006), new ways of teaching and learning involve the use of various ICT tools and digital content as a part of whole class, group and individual student activities. He also reported that the first to be embedded in schools are new technologies that are suitable with existing practices, for example interactive whiteboards. However, with training to support innovative pedagogy, teachers could gradually integrate other technology.

Even though the results of the ImpaCT2 study showed that majority of teachers perceive the potential benefits of collaborative working with ICT, a small number of them actually take advantage of those benefits (Harrison et al., 2002). In the study teachers mostly expressed they refer to ICT as a tool. As the authors state, this finding suggests that ICT is merely an addition to existing practice. An ICT tool is as valuable as is the teachers' ability to use it in a meaningful pedagogical way. Although teachers often believe that technology should be used for high-level problem-solving activities, they mostly use drill and practice applications (Ertmer, 2005).

In Croatia (Center for Applied Psychology, 2015b), teachers mostly emphasised the importance of development of students' knowledge and skills through in-depth learning and problem-solving activities. They were more oriented on encouraging students' active learning compared with one-way knowledge transfer or skill demonstration. Moreover, teachers in primary schools were more prone to teacher-centered teaching than those in secondary schools.

The finding that teachers use ICT to support existing pedagogies is something many more researchers have come to conclude. Denmark's national ICT project (Ramboll Management, 2005), revealed that teachers change their way of thinking about the application of ICT in education, but not their use of ICT in educational processes. The authors of the project concluded that teachers insufficiently take advantage of the creative potential of ICT and that they should use it to engage students more actively in the educational process.

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Moreover, the authors of The ICT Impact Report (Balanskat et al., 2006) also provided evidence that majority of teachers still use existing teaching practices and that, although the foundations for new teaching practices have been laid, more time and effort are needed for them to be adopted by teachers. The authors assume that there are three stages of ICT integration. In the first stage, ICT is used to support existing practices. It is increasingly built into curriculum in the second stage, and only in the third stage is ICT used to remodel teaching practice. Except for a small group of teachers who embrace ICT much faster, the majority of teachers will adapt to the new technology at a much slower pace. It should be emphasised that any change in the teachers' pedagogical practice is a long term process, therefore the outcomes will not be rapid. Furthermore, school leaders also think that the effect of ICT on teaching methods in their school is low. Only 42% of school leaders believe that ICT has to a large degree contributed to the change of existing teaching methods, even though 90% of them think of ICT as a tool for teaching and school development.

However, there are examples of teachers who shift their approach after they integrate ICT into their teaching and learning. Ruthven and Hennessy (2002) studied teaching practice behind teachers' successful use of ICT in teaching mathematics. While transmission approach is related to transfer of knowledge from teacher to student, constructivist approach is associated with students learning through reconstructing and adding to their existing knowledge. Math teachers as a group are more prone to a transmission approach, however, the use of ICT made them change their approach more toward a constructivist one.

It is, however, important to note that teachers are not the sole determinants of educational processes. Schools have different curricula and policies that have an immense influence on the integration of ICT into teaching and learning and reaching its full potential (Balanskat et al., 2006). The new approach to teaching and learning requires changes in the curricula that emphasise depth of content understanding, and assessments that emphasise the generalization of learning. Teacher pedagogies that encourage this approach include problem-based learning, which allows students to explore a subject in depth and develop their own knowledge on complex issues. They also include student-centred teaching, whereby teachers'

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role is in designing the activity, guiding students understanding and supporting students in collaborative projects (Hine, 2011).

Furthermore, it is believed that the way in which teachers use ICT in teaching and learning results from how they reason about their work. Their reasoning is based on their knowledge, beliefs and experiences with ICT (Sang, Valcke, Van Braak, & Tondeur, 2010). Numerous research studied the effect of teachers' educational beliefs (Prestridge, 2012) and knowledge (Kafyulilo, Fisser, Pieters, & Voogt, 2015) on their use of ICT in teaching processes, however, the findings about the reasoning behind teachers use of technology in class are still inconclusive. Teachers' professional knowledge is also referred to as practical knowledge. It is defined as the knowledge and beliefs that determine teacher actions (Heitink et al., 2016). According to Voogt, Fisser, Tondeur, and van Braak (2016), practical knowledge develops through teachers' reflections on daily experiences in class, and is based on their formal knowledge and beliefs about technology and education. Heitink et al. (2016) further state that teachers develop learning activities that conform with either transfer or construction of knowledge, based on their practical knowledge. In their study, the authors found that teachers' use of technology in their teaching practices is mostly related to a knowledge transfer model of teaching (e.g. practicing knowledge and skills, traching the whole classroom). That finding was supported by other studies, suggesting that teachers are more oriented toward using technology in environments that are teacher-centered (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur 2012).

When using any form of technology there are complex relationships between content, technology, pedagogy and context. Mishra et al. (2009) introduced Technological Pedagogical Content Knowledge (TPACK), as an important element of teachers' professional knowledge when they plan to integrate ICT in their teaching practice. It proposes that technological knowledge should be a relevant part of pedagogical knowledge, suggesting that teachers require more than basic technological skills to be able to use ICT to modify their teaching approach to students with different interests and capabilities. Having TPACK helps teachers in their selection of appropriate technologies that fit with the pedagogy in a specific teaching

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context. According to Cox and Webb (2004), use of ICT that has a poor fit with teacher pedagogy and subject content, as well as irrelevant use of technology, can result in negative learning effects. Heitink et al. (2016) supported the idea that teachers who use technology succesfully in their teaching processes should be able to 'fit' pedagogy and content with ICT. They argue that one of the most important aspects of successful integration of ICT in education is the teachers' ability to know whether and how the ICT equipment and resources they select are crucial or supportive for realizing the goals of particular teaching and learning activity.

Another view on the change of teacher pedagogies with the use of ICT is offered by Prieto, Dimitriadis, Asensio- Pérez, and Looi (2015). They assumed that the problem with teachers not changing their approach may be a consequence of orchestration. It concerns integrating the planned use of ICT into teaching and learning. Based on his research, he suggested five key aspects in characterising orchestration: design (preparation and organisation), management (time, group, classroom, etc.), awareness (students' learning progress), adaptation (opportunities) and roles (teachers' and students'). Based on these aspects of orchestration, Newhouse (2016) argues that they can be translated to six basic steps that teachers follow:

1. Identify potential
2. Select appropriate software
3. Organise access
4. Select appropriate model of implementation
5. Manage the implementation
6. Evaluate success.

However, Newhouse (2016) emphasises that, in order for ICT integration to lead to positive learning gains, it is essential for teachers to improve student assessment. Assessing student performance with only pen and paper is lacking, since it does not truly represent or capture students' knowledge and understanding. ICT provides the potential to refocus summative

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assessment, to increase authenticity and, consequently, encourage a more problem-driven approach to the development of knowledge and skills in schools.

3.3.3. ICT and Teachers' Digital Competence

Since teachers' digital competencies have previously been explained in detail in section 'Digital Competencies', here we briefly describe the results on teachers' digital competencies in Croatian schools.

In a study conducted in 20 Croatian schools, it was found that teachers in majority felt they were most competent in using the Internet safely and responsibly, and a little less competent in all other dimensions (social media, operational and problem solving skills). When the authors took gender into account, it was found that male teachers gave higher scores for their self-reported digital competence, in comparison with female teachers. Also, teachers with less than 10 years of experience, teachers who teach STEM subjects and those who perceive more benefits and less risks of ICT use in school reported higher scores for digital competence (Center for Applied Psychology, 2015b).

Furthermore, when investigating the relationship between the frequency of ICT use, attitudes towards ICT use in class and teachers' digital competencies, the results revealed that there was a more significant relationship between the frequency of ICT use (and access to the Internet) and digital competencies than between the frequency of ICT use and teachers' attitudes toward ICT (Center for Applied Psychology, 2015b). Also, Pahljina-Reinić et al. (2016) stated that teachers who have more positive attitudes towards ICT in education reported higher levels of digital competence. They also suggested that the most relevant predictors of teachers' perceived digital competence were fewer years of teaching experience and higher mastery goal orientation.

In addition, the most significant relationships with digital competencies were found for teachers' frequency of laptop, smartphone and Internet use. Interestingly, teachers' digital competencies were more related to their frequency of ICT use at home than the frequency of

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ICT use at school. The most significant relationships, although small, were found between teachers' digital competencies and their frequency of smartphone and Internet use (Center for Applied Psychology, 2015b).

3.3.4. ICT and Teachers' Perceptions and Attitudes

Teachers are in the classroom with the students, they know how ICT is used, and directly experience its effects. Promoting teachers' positive perceptions about technology can significantly increase the likelihood that they will accept and use the technology in their teaching. As Buabeng-Andoh (2012) stated in his paper, teachers' attitudes and beliefs are crucial when it comes to implementation and integration of ICT in schools. Many other authors consider teachers' attitudes and beliefs to be among the key factors that influence successful integration of ICT (Hew & Brush, 2007; Keengwe, Onchwari, & Wachira 2008).

Teachers' use of new technology in their teaching and learning depends on whether they will find it useful for them and their students. Also, they can provide useful insight about the advantages and shortcomings of ICT in teaching and learning, particularly if their attitudes towards the use of technology is positive. Moreover, teachers' attitudes and beliefs towards technology strongly influence their acceptance of the technology and its integration into teaching and learning processes (Huang & Liaw, 2005).

Cox and Webb (2004) made a list of some common perceptions teachers have about ICT. Teachers feel that ICT can significantly contribute to their teaching and learning process by helping them explain things more clearly, making lessons more interesting and encouraging them to change the ways of teacher-student interaction. Also, they think ICT can be used in most subjects and that it can be very useful when it comes to preparing for educational activities beforehand. Furthermore, since they started using ICT in teaching and learning activities, teachers believe that there are significant benefits for learning when using ICT. Some of those benefits are related to better students' control over the learning process, immediate feedback of their actions and decisions, simulations that help students distinguish, change and control variables, and also help students' conceptual understanding. Moreover,

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teachers perceive benefits in students' ability to collect data and do an experiment using interactive whiteboard, in order to hypothesise and predict outcomes of processes, and to explain things to other students. Teachers also feel they can focus on more important tasks of supporting students' scientific thinking, and, especially with the use of interactive whiteboards, they can introduce students with the theory behind topics. They think ICT also encourages students' reflection on their work and enables them to evaluate their own and the work of other students. Teachers believe that with the use of ICT, students have the possibility to access more knowledge during school time (Cox & Webb, 2004).

Furthermore, in a study conducted by Heitink et al. (2016), it was concluded that teachers perceive the value of ICT use in teaching and learning, mostly because of its attractiveness, efficiency and effectiveness for either their teaching or students' learning process. Majority of teachers reported they use ICT in class to make the learning process more attractive and motivating for students. Also, the results have shown that teachers relate their use of ICT mostly to supporting educational goals and facilitating the learning process. Other common reasons for ICT use were formative assessment and education for individual student needs, including students with difficulties and gifted students.

As identified in the Nordic study (Pedersen, 2006), teachers who are more intense ICT users recognize a greater positive influence ICT has on the educational process. Also, once they overcome the basics of ICT use, they don't see it as time consuming.

In Croatian schools it was found that teachers equally perceive benefits and risks of ICT use. The results showed that teachers in primary schools perceived more benefits than secondary school teachers, and also that teachers with 20 or more years of teaching experience perceived less risks than teachers with 10-20 years of experience. Moreover, teachers who teach STEM subjects percieved more benefits than teachers of humanities and social sciences. The authors also investigated the relationship between teachers' attitudes towards ICT use in education and their teaching practice. The results showed that teachers who perceived more benefits of ICT use were oriented on encouraging active learning, they perceived more benefits of daily ICT use, and felt they were efficient in ICT use (Center for Applied Psychology,

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2015b). In addition, it was found that significant predictors for perception of benefits of ICT use in learning were perception of school value and self-efficacy, perception of benefits and risks of ICT use in general and intrinsic interests for ICT use (Mohorić et al., 2016). Concerning perceived risks, teachers who are more oriented on information transfer and who felt they were less efficient in ICT use perceived more risks of ICT use in teaching and learning (Center for Applied Psychology, 2015b).

Moreover, the results of the case study conducted in two Croatian primary schools showed that there was a significant difference in attitudes between teachers who use tablet PCs and those who don't. Teachers in a school in which students used tablet PCs had more positive attitudes toward ICT use than teachers in a school in which students don't use tablet PCs in class (Kolić-Vehovec et al., 2015).

Regarding gender differences, Kay (2006) conducted a research which findings suggested that male teachers had more ability and more positive attitudes towards ICT than female teachers before ICT implementation. However, after the implementation of ICT, there was no significant difference found between male and female teachers regarding ICT attitude and ability. These findings may suggest that potential gender inequalities can be reduced by quality ICT preparation (Buabeng-Andoh, 2012).

3.4. Disadvantages of ICT Use in Education

When considering ICT use in teaching and learning, it is also important to take into account the potential disadvantages it may bring. In the study conducted by Watson, Ito, Smith, and Andersen (2010) it was reported that only a minority of adolescents use ICT for activities such as seeking knowledge on the Internet, developing advanced computer or media skills or actively participating in different network communities, that could provide meaningful learning experiences. The majority of adolescents unfortunately used ICT for engaging in relatively trivial social activities, such as exchanging instant messages or updating their status on social media.

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Salmela-Aro and her colleagues (2016) stated in their paper that many digital applications and programs available to young people are designed in a way that increases addiction and requires sustained participation. Therefore, there is a potential danger that some adolescents will become addicted to immersive socio-digital activities. Also, intensive participation in socio-digital activities may disturb activities regarding school work and daily life in general, especially circadian rhythms of waking and sleeping (Kaltiala-Heino, Lintonen, & Rimpelä, 2004). Furthermore, according to Carr (2011), many mobile applications continuously interrupt ongoing activities and draw vulnerable adolescents onto repeated on-line activities.

There are also a number of papers which consider disadvantages of multi-tasking behaviour and switching attention from one situation to the next, which is often associated with the use of ICT. Some authors agree that such behaviour can obstruct memory, attention, learning and creativity (Carrier, Rosen, Cheever, & Lim, 2015).

Moreover, numerous papers were published on the difference between print and screen reading. When people are trying to locate a particular piece of information they have read, they can often remember where to find it if they read it from a printed text. However, when reading from a screen, people have a hard time differentiating pages and positions of a text on a page. It can be argued that by reading screen texts, students have a superficial approach to reading. It was found that, when reading from screens, students seem less inclined to engage in metacognitive learning regulation (e.g. rereading complex sections, setting specific goals, checking understanding of content). However, when the task was to read quickly, students using computers or paper text performed equally well (Jabr, 2013).

Pregrad et al. (2010) stated in their paper that ICT provides children and adolescents access to various attractive content, which could be dangerous because of their underdeveloped ability to recognize or understand potentially harmful content. The authors also specified potential harmful content: threatening messages, messages containing insults and vulgarities, false presentation, public personal information and data, on-line social isolation, etc. The results of their study in 23 Croatian schools showed that both teachers and parents expressed stronger perception of the dangers associated with the Internet, than the perception of

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positive aspects of Internet use. As mentioned previously, in another study conducted in Croatian schools (Center for Applied Psychology, 2015b) teachers equally perceived benefits and risks of ICT use in schools, however, teachers who perceived more risks were more often oriented on information transfer and felt less efficient in ICT use. Teachers, as well as students, also reported they felt most competent in using the Internet safely and responsibly, but less competent in social media, operational and problem solving skills. Students reported they felt the least competent in their social media skills.

Clarke and Svanaes (2012) report that there may be a lack of content and tools developed to help students navigate the reliable sources of information and the quantity of information available. Teachers and parents that participated in the study both expressed a concern that this skill is overlooked, and that students will take time to understand the need for ensuring validity and reliability of on-line content. Also, teachers expressed their concern that ICT could be a distraction in lessons, namely because of the access to certain websites it provides (games, networking sites). Parents were more concerned for the safety of ICT use and afraid of potential overdependence in technology their children might develop.

In a research on potential problems associated with students' use of technology (Salmela-Aro et al., 2016), the results showed that excessive Internet use predicted later school burnout and later depressive symptoms, and, moreover, that school burnout predicted later excessive Internet use. After examining gender differences, it was revealed that girls suffered more than boys from depressive symptoms and school burnout. It was also found that boys were excessive Internet users more often than girls. The results of the study indicate that excessive Internet use can have an effect on school-related mental health, which can later on result in depressive symptoms. Excessive Internet use can also lead to an increase in all three components of school burnout (a cynical attitude toward the school, feelings of inadequacy as a student, and exhaustion at school). The authors of the study conclude that adolescents are in danger of excessive participation in repeated meaningless activities and, consequently, of excessive Internet use. Therefore, they should be offered structured activities which facilitate constructive and creative ways of using ICT.

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3.5. Methodological Issues

The main goal of this section is to present most frequently used ways of investigating the effect of ICT on experiences in student's learning in terms of experimental and quasi-experimental designs, and qualitative and quantitative methods of data gathering and analysis. More specifically, some basic problems related to both conceptualization and operationalization of ICT implementation as well as outcome measures will be highlighted. Finally, some recommendations for improving the quality and validity of future studies will be given.

3.5.1. Approaches to Investigating ICT Effect on Outcomes

There are several potential research designs when it comes to studying the effects of ICT on students' learning outcomes. One possible choice is related to the decision whether to use experimental or quasi-experimental study. Given ethical issues related to experimental designs, studies with quasi-experimental designs are far more common. The essential characteristic of this type of inquiry is that the researchers compare the performance (i.e., outcome variable) of students which use ICT (at home, at school, or both), and in methodological terms represent the 'experimental group' with the performance of students that do not use ICT, and therefore present the 'control group'. The fundamental shortcoming of quasi-experimental design in this field is that finding mutually exclusive groups is extremely hard to find. In other words, it is difficult to detect students who have zero access to ICT (Biagi & Loi, 2012). Generally, an important drawback of this type of studies is lack of control, i.e. other variables which are related to both ICT use and outcome variable of interest might be 'responsible' for the potential significant finding that ICT use indeed leads to better results in the outcome variable.

Across the literature, the dominance of quantitative in comparison to qualitative research is evident. From total number of 352 papers on ICT in schools published in journal *Computers & Education* in period from 2011 to 2015, only 55 included qualitative methods (Pérez-

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Sanagustín et al., 2016). Even when qualitative methods are used, they are combined with quantitative methods. The main issue regarding the quantitative studies, despite their frequency, is that the number of included participants is relatively small (usually these are experimental and quasi-experimental studies with sample sizes less than 100) and period of data gathering is quite short. Less than 50% of quantitative studies cover more than 12 weeks of data gathering (Pérez-Sanagustín et al., 2016). As far as studies using qualitative design are concerned, existing evaluations are mostly based on self-reported data, and usually lack validation or triangulation through multiple sources. It is clear that balance in quantitative and qualitative methods use is needed, i.e. more importance should be given to qualitative methods (Pérez-Sanagustín et al., 2016). Furthermore, it can also be concluded that increased methodological rigor and quality is necessary in both types of designs.

Given the fact that ICT implementation in schools is a long-term endeavor, it is important to keep track of the effect of implementation in longer time periods. Namely, sometimes it will take years for teachers to successfully and efficiently integrate technology into their teaching practice (Tolani-Brown et al., 2008). Besides, researchers and other interested parties should keep in mind that it takes time for intervention effects (in terms of students' outcomes) to manifest (Cox & Abbott, 2004). In line with previous claims, a number of studies (e.g., Bhattacherjee, 2001) show that attitudes toward technology change in the function of time. Courtois et al. (2014) emphasize the need for longitudinal studies which will enable researchers to follow the dynamics and problems which appear when ICT is implemented in teaching process.

When comparing and interpreting the results of different studies, cultural context of given interventions has to be considered. Direct cultural comparisons may be inappropriate, and cultural context in which studies of the role of ICT in education are conducted should be broadened (Perez-Sanagustin et al., 2016).

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3.5.2. Measures of ICT Implementation

Regardless of the study design (i.e., experimental or quasi-experimental), the issue of conceptualization and operationalization of ICT implementation is relevant. Namely, the way the ICT and ICT implementation are defined determine the approach to its measurement (Jamieson-Proctor & Finger, 2008). Since unambiguous definition of ICT integration is lacking, consequently there is no single way to operationalize it. Some studies use simplified measures (e.g., number of computers), while stronger evidence for ICT effects in students arise from research that focus on specific use of ICT. More specifically, these studies identify the range and types of ICT use (Marshall & Cox, 2008).

Although the main research interest lies in determining the effects of ICT use on particular outcomes, as previously mentioned, it is questionable if they can be attributed to ICT implementation (Cox & Abbott, 2004). Besides already considered confounding variables, technology implementation is, with no doubt, related to changes in teaching (at the minimal level, teaching approach had to be changed in order to integrate ICT). Therefore, researchers need to keep in mind that several relevant variables are changed along with ICT implementation. It follows that it is not justified to attribute all effects in outcomes to only one element (i.e., technology) (Kirkwood & Price, 2015). To determine the conditions in which ICT activities can improve learning and skills with higher certainty, it is of great importance to evaluate the process of teaching and learning in more concrete terms (Balanskat et al., 2006). Besides teaching styles, there are other factors which affect the outcomes. In order to gain better, more accurate, and integrated picture, these factors should be included in the analyses (Savelsbergh et al., 2016).

The causal relationship between one factor (e.g., usage of a specific tool) and outcome (e.g., learning outcome) is very hard to prove, since there are numerous control variables (e.g. students' attitudes, teaching process) which affect this relationship and which need to be considered. Although it may be simple to test direct effects of an input such as the quality of Internet connection and an output such as Internet use, real educational environment is much more complex. In such setting, simultaneous and numerous factors are at work, which makes

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the identification of relationship between a single factor and a single output much harder. There are several variables which should be controlled 'in ICT studies, due to their proved effects on different outcomes, and despite their problems with operationalization and measurement. These include motivation, teachers' expectations, and students' self-image.

There are other relevant characteristics that may affect the outcomes besides interventions and the level of teachers' preparation, such as grade, age, gender, and socio-economic status (Slavin, Lake, Hanley, & Thurston, 2014). It is therefore recommended for researchers to have in mind the structure of the class in terms of age, gender, cultural background, socio-economic status, educational level, time frame, and actual duration of students' activities, as well as the duration of teachers' preparation. Additionally, it is crucial to report the interventions in much detail, in order for other researchers to be able to replicate or evaluate their type and quality (Savelsbergh et al., 2016).

Many studies are focused on students and ignore teachers' behaviors (e.g., how do teachers integrate ICT into practical lessons). Pérez-Sanagustín et al. (2016) reported that in 77% of studies (N=269) the participants are students, while 240 did not include any other group. Although it is clear from published studies that the ways in which teachers use ICT in schools and why are extremely important (Fu, 2013), only 30% included teachers as subjects. However, involving the teachers is crucial for positive effects of ICT to take place (Darling-Hammond et al., 2015).

Mishra and Koehler (2006) introduced the construct 'Technological Pedagogical Content Knowledge' which is an important element in teachers' proffesional knowledge, especially when they intend to integrate technology in their work. It is assumed that technological knowledge needs to be integrated as part of the pedagogical knowledge content. This implies that teachers need more than basic technological skills in order to use technology in ways that enriches their pedagogical approach as well as their capabilities to teach diverse content to students of different interests and skills. If teachers possess such knowledge, it will enable them to choose adequate technology in line with pedagogy and content within a specific

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context. Irrelevant technology use, and technology use inappropriate for pedagogy and content may lead to negative effects on learning.

3.5.3. Outcome Measures

From conceptual point of view, when conducting a study, the researchers have to decide which outcomes they are interested in. This often poses a problem in studies which aim to determine the effects of ICT implementation. More specifically, chosen outcome measures are frequently inadequate. Namely, it is often the case that progress in traditional processes and knowledge is expected, while change happens in domains conceptually and practically more relevant to the intervention, which are not included in the study (Cox & Abbott, 2004). In other words, this means that disaccord may appear between anticipated goals (as well as measurement methods used) and nature of learning which occurred while using ICT (Balanskat, et al., 2006). It is likely that technology use will result in knowledge deepening and increase in understanding (and not necessarily increase in factual knowledge) or in development of different generic or life skills (such as critical thinking, ability for appropriate communication with different audiences, collaboration, etc.) (Kirkwood & Price, 2015).

In their paper which focused on suggestions for improving the quality and validity of research in learning technologies, Kirkwood and Price (2015) emphasize the need for more precise definition of the domains in which effects of particular technologies can be expected. They asserted several such domains, such as increase in technology use, improvement in learning conditions and teaching methods or in learning outcomes (quantitative and qualitative). The authors further cited that the researchers need to consider the ways in which progress in domains of interest will be manifested (e.g., more frequent use, increase in time of task engagement, higher students' satisfaction with teaching, quantitative or qualitative changes in learning).

Regardless whether the progress is defined in quantitative or qualitative terms, it is never satisfactory only to ask students to evaluate if changes in their learning have occurred. This type of inquiry not only will fail to show if the progress has really happened, but is also

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inappropriate. In other words, it is unjustified to assume that every student operationalizes this concept in the same way the teacher does (Kirkwood & Price, 2015). Other possibility refers to using achievement tests. However, this approach also poses certain challenges. Achievement tests are mostly thematic and specific for a certain domain, and most studies use specifically designed measures of attainment for a particular task. As a result, this makes the evaluation of quality more difficult, while in many studies such measures are more in accord with the content taught in experimental situation, than the one taught in control situation (Savelsbergh et al., 2016). On the other hand, the standardized tests are more in line with traditional curricular outcomes. Slavin and Madden (2011) did a systematic review of studies which focused on outcomes in domains of mathematics and reading. They found that measures inherent to the treatment (i.e., measures which cover the content not presented to the control group) are related to stronger effect sizes than curricular measures in experimental and control groups. Meta-analytic results by Schroeder, Scott, Tolson, Huang, and Lee (2007) are, however, completely opposite; in 47 out of 62 designed achievement tests, no significant differences in outcomes were found.

The existing literature includes large number of instruments for measuring ICT literacy, which range from paper-pencil tests, multiple choice, short answer tests, to more interactive performance-based scenarios. Besides those, questionnaires for students' self-reports of ICT literacy are widely used, and are interpreted as true indicators of students' ICT literacy (e.g., Aesaert, van Nijlen, Vanderlinde, & van Braak, 2014; Hakkarainen et al., 2000). However, these indirect measures usually cover self-confidence or self-efficacy, which present only a rough estimate of actual competencies. Namely, the comparison of digital competencies measured with self-ratings and actual performance indicated to their low correlation (e.g., Hakkarainen et al., 2000). Using self-reports as indicators of actual competencies levels is unreliable because self-assessments are biased and demonstrate beliefs about competencies, and not real competencies (Siddiq et al., 2016). Performance-based tests, on the other hand, enable students to show their abilities in a particular activity, to generate their response or create a product (Madaus & O`Dwyer, 1999). Given those potentials, performance-based tests can provide a better approximation of actual thinking and reasoning.

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Most of these performance-based tests are related to computer application, although traditional forms are present, such as paper-pencil. Siddiq et al. (2016) cited that digital literacy assessments vary as a function of various dimensions like interactivity level (static/interactive ways), assessment structure (task presentation to students), response format (response selection or construction – questions of opened or closed type), and scoring (automatic or scoring by hand). The examples of categories of different tasks/items in ICT literacy assessment are shown in Table 3 (Siddiq et al., 2016).

Table 3. *Categories of Task/Item Types in ICT Literacy Assessment (Siddiq et al., 2016)*

Category	Description	Example
Multiple Choice	Tests that mainly consist of constrained response formats. The information provided is to a large degree static.	Standardized multiple-choice tests with given response options.
Multiple Choice with Interaction	Tests that mainly consist of constrained response formats. The information provided is to a large degree dynamic.	Task/item stimuli are based on interactivity or the test-taker need to interact with the test environments to find the right answer which is given as a selected response.
Interactive	Tests that to a great degree consist of items that require the test-taker to interact with the test environment to provide a response to the items. The information to the test taker is provided dynamically.	Tasks in which test-takers need to set the values of a number of variables of a given system (e.g., an artificial remote control), observe the outcomes, and draw conclusions on the relations between the variables.
Authentic	Tests in which the test-taker is provided with tasks that represent a fully authentic situation. No interaction with a typical test environment is required.	Tests in which the test-taker receive tasks from an administrator, and his/her actions are observed and scored while solving the tasks on a digital device, and without dealing with a particular computerized test environment.

The researchers emphasize the advantages of authentic digital literacy assessments, given that such methods are more reliable and valid measures of competencies (Kane, Crooks, & Cohen, 1999). Standardized multiple choice measures are criticized because students are presented with structured options which do not reflect performance in everyday life (Stecher, 2010). Some criticisms are related to claims that multiple choice measures cannot grasp 21st

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century students' skills such as problem solving, critical thinking, or ICT literacy (Darling-Hammond & Adamson, 2010).

According to Siddiq et al. (2016), a significant part of recent literature related to ICT literacy aims to structure and synthesize conceptualizations and theoretical frames of the construct. However, they rarely focus on empirical studies which evaluated ICT literacy measures. In addition, current studies of measures related to ICT are focused on one aspect, mainly informational literacy (Beile, 2008) and basic Internet use skills (Litt, 2013). Therefore, an inclusive and integrative evaluation of ICT literacy as a broader concept and inquiry of its psychometric properties is needed (Siddiq et al., 2016). Namely, according to Siddiq et al. (2016) not many studies which focused on evaluation of ICT literacy assessment are available.

When examining the outcomes, researchers are usually concentrated on only one source of information. However, much better insight into the efficacy of introducing ICT in the educational context could be gained by using multiple information sources (Tolani-Brown et al., 2008). The studies which neglect the teachers' perspective (i.e., their perceptions of ICT use in everyday practice) are missing important information (Pérez-Sanagustín et al., 2016).

3.5.4. Recommendations for Improving the Quality and Validity of Research

Although numerous studies which focused on investigating the effects of technology innovations on the learning process have been conducted in the recent years, a great amount of issues related to the process of designing and conducting such studies can be identified. Kirkwood and Price (2014) emphasize that in existing reports there is not often a clear description of the nature of progress which is expected to be the result of the technology, i.e. of the effects which technology has on students' experience of learning. Moreover, it is argued that the interventions are primarily guided by mere implementation of technology with disregard in the matter of reaction towards issues related to teaching and/or learning. According to the noted issues, Kirkwood and Price (2014) suggest the necessity of a better conceptualization of goals, purpose and rationale of a certain innovation, as well as of the assumptions in the basis of teaching, learning and progress. Better understanding will

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influence not only the methodology of studies and methods of collecting data but also clarify the frameworks within which the results can and should be interpreted. The following suggestions are to be accentuated with regard to improving the quality and validity of research (Kirkwood & Price, 2014):

1. *Specifying the aims and rationale of the e-learning project*

    Before deciding on the most suitable research approaches and methods, it is required to clearly define the reasons for introduction and implementation of a certain technological innovation, i.e. to define goals which are sought to be achieved through the technological innovation. Moreover, it is necessary to precisely define the areas in which progress is expected with the use of certain technology, i.e. to define the measures of outcomes.

2. *Specifying the pedagogic purpose of a technology implementation project*

    Through examination of published research and evaluation studies related to technology implementation, Kirkwood and Price (2014) underline three categories of potential aims of technology implementation: repetition of existing teaching methods, supplement of existing teaching methods or a transformation of the teaching and learning process, as well as its outcomes. Expected outcomes in studies are occasionally not in accordance with the type of intervention, therefore, it is unjustifiable to expect that, for example, projects focused on reproduction of existing teaching methods will lead to a transformation in students' learning process. Merely changing the way in which an information is presented does not significantly alter the function itself (a lecture is a lecture equally in a classroom, on a web page or via video).

3. *Conceptualization of expected progress in terms of the process and experiences of students involved*

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A progress in the learning process can be observed in quantitative as well as qualitative terms. Quantitative definition of progress can be represented in the comparison of grades or scores students achieved on attainment tests in experimental and control groups. On the other hand, interventions can lead to qualitative changes (for example, already mentioned changes in the level of knowledge, development of critical thinking, etc.).

4. *Appropriate conclusion and avoidance of unsubstantiated generalizations and recommendations*

Conclusions and recommendations must be substantiated by research results (Kirkwood & Price, 2014). It should be noted that a variation of variables, in addition to ICT intervention, can result in changes in the observed outcomes. Furthermore, there is a risk in generalizing the obtained results with regard to the context within which certain studies were conducted. Results of a study conducted within a certain context do not necessarily apply to other contexts. It is, therefore, of extreme importance that researchers accurately specify the circumstances of a certain intervention, as well as the methods of measuring students' outcomes.

3.6. Conclusion

Teachers' and students' use of ICT varies greatly, depending on the equipment available in schools, national policies and other conditions that differ across various countries and schools. From the review on student outcomes that result from the use of ICT in teaching and learning it can be concluded that ICT can have a significant positive effect on student performance at school, it can increase their motivation and attitudes toward learning with the support of ICT, and enhance their digital competence, as well as their learning skills. Also, ICT use in class can provide great potential benefits for students with special needs. Still, for these outcomes to be achieved, the role of teachers (e.g. their digital competence, teaching pedagogy, motivation etc.) is essential. The use of ICT in education can also result in significant positive

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outcomes for teachers. If used adequately, it can increase their work efficiency, their digital competence and change their attitudes for the better. Change in their teaching practice is a long term process, so the effects of ICT use on teaching methods are still not significant. Teachers still mostly use ICT to support their existing teaching methods.

However, it is important to emphasise the limitations in assuming causal relationships between the use of ICT and measured outcomes. There are many possible moderators of that relationship that could influence conclusion on the effects of ICT. Still, it can be concluded from this review that ICT can have a significant positive effect on both students and teachers, but only implementation of equipment is not sufficient by itself. Digitally competent teachers that are prepared to change their pedagogies are crucial for the effects of ICT use to happen.

3.7. Final Review of Croatian Studies on ICT in Education

As can be seen in the previous text of this Report, Croatian studies of ICT in the educational system are only starting to gain popularity. To this date, and in collaboration with CARNet, Center for Applied Psychology (2015a, 2015b) in Rijeka has conducted two studies in this domain. Relevant findings were previously cited throughout the Report, and were presented on conferences, both in Croatia (e.g., Mohorić et al., 2016; Pahljina-Reinić et al., 2016) and abroad (e.g., Kolić-Vehovec et al., 2015). Other researches on ICT in schools include the one from Pregrad and associates (2011) and an unpublished doctoral dissertation by Purković (2016). Also, a large-scale study Survey of Schools included Croatian sample (European Commission, 2012). The most important findings that were previously described in the text are summarized here, and include:

- Croatia was below the EU mean for available ICT infrastructure (European Commission, 2012),
- Croatia was below the EU mean for most indicators related to teachers' ICT training (European Commission, 2012),

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- The percentage of students that attend digitally supportive schools in Croatia was somewhat lower than the EU mean (European Commission, 2012),

- ICT strategies implementation in Croatian schools was below the EU mean (European Commission, 2012),

- Croatia was in the middle group of countries when it comes to frequency of ICT activities during the lessons (European Commission, 2012),

- Percentages of students taught by digitally supportive teachers were consistently below the EU mean (European Commission, 2012),

- Male teachers and teachers with less working experience assessed their digital competences higher than did the female teachers and teachers with more experience (Center for Applied Psychology, 2015b),

- Digital competence level was related to ICT use in schools (Center for Applied Psychology, 2015b),

- Teachers assessed their computer self-efficacy quite positively (Center for Applied Psychology, 2015b),

- Teachers of STEM subjects had higher levels of computer self-efficacy than languages and humanities teachers (Center for Applied Psychology, 2015b),

- Teachers with higher computer self-efficacy perceived more advantages and less risks related to ICT use (Center for Applied Psychology, 2015b),

- The strongest predictor of frequency of ICT use for teaching was teachers' computer self-efficacy (Pahljina-Reinić et al., 2016),

- Teachers equally perceived external and internal barriers to ICT use (Center for Applied Psychology, 2015b),

- Perception of benefits of ICT use for teaching predicted actual level of use (Pahljina-Reinić et al., 2016). Teachers' perceptions of benefits of ICT use for teaching and learning were predicted by student-centered teaching approach, perception of benefits of ICT use in everyday life and computer self-efficacy (Center for Applied Psychology, 2015b),

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- Tablet use was related to perception of more positive and less negative aspects of ICT use (Kolić-Vehovec et al., 2015),

- Teachers which perceived more advantages of ICT use were more oriented at encouraging active learning (Center for Applied Psychology, 2015b),

- 50% of students used the Internet every day. Boys and older students used the Internet more frequently (Pregrad et al., 2010),

- Students used ICT mostly for social networks, finding entertaining and interesting content and browsing the Internet. With regard to school activities, students mostly used ICT for material and task exchange and finding additional content which might assist them in writing, learning and preparation for lessons (Center for Applied Psychology, 2015b),

- Students' confidence in ICT skills was variable, depending on the type of skill. However, it was mostly below or equal to the EU mean (European Commission, 2012). Most students reported that they felt most competent for safe and responsible Internet use, and less competent in other skills. They assessed their confidence in skills for social media use as lowest of all (Mohorić et al., 2016),

- Students which use tablet PCs had more positive and less negative attitudes towards ICT (Kolić-Vehovec et al., 2015).

Therefore, it can be concluded that pilot project e-Schools and its evaluation is very important, not just for keeping the pace with international trends, but also for acquiring knowledge that can be of extreme value in the process of digitalization of schools.

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4. STUDY AIMS AND HYPOTHESES

In light of previous findings presented in the literature review, we formulated five general aims of the study and corresponding hypotheses. For each general aim, several specific aims were defined. Furthermore, relevant findings are shortly presented in order to provide sound basis for hypothesis construction.

4.2. First Aim

The first aim of the study is to examine the effects of the pilot project on students' general affective and specific cognitive learning outcomes. The project activities refer to ICT activities applied to mathematics and natural sciences. Furthermore, four specific aims (SA) were formulated. These refer to effects of ICT activities related to school and learning (SA1.1), digital educational content (SA1.2), teachers' and other educational staff's digital competencies (SA1.3), and infrastructure type (SA1.4) on students' general affective and specific cognitive learning outcomes.

The effects that ICT use in schools could have on students' cognitive and affective outcomes have been investigated many times by different researchers. As mentioned previously, results of various studies repeatedly show that the use of ICT in teaching and learning can have a significant positive effect on students' learning outcomes (Harrison et al., 2002; Higgins et al., 2005). In both primary and secondary schools, the most extensive use of ICT in teaching and learning has been precisely in science and mathematics (Center for Applied Psychology, 2015b, Cox & Webb, 2004). Since Watson (1993) provided data which supported his hypothesis that a computer programming language significantly improves students' mathematical reasoning and their performance in mathematics, a number of studies investigated the relationship between the use of different ICT equipment and students' attainment in mathematics. Most studies revealed that ICT can be helpful in developing mathematical reasoning (Harrison et al., 2002; Kramarski & Zeichner, 2001) and in achieving

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higher scores in mathematics tests (OECD, 2006). The positive relationship between ICT use and students' attainment in science has also been found in many studies (Cox & Webb, 2004; Cox et al., 2003; Harrison et al., 2002). The frequency of students' ICT use as well as ICT-assisted instruction in class have been associated with higher student achievement in science. In terms of affective outcomes, numerous studies provided evidence for increases in students' motivational variables as a result of ICT use (Cox & Abbott, 2004; Passey et al., 2003; Underwood, 2006). It was found that ICT use can have a strong motivational effect (Berson et al., 2012; Murray & Olcese, 2011; Pedersen, 2006).

When it comes to teachers' digital competencies, they have proved to be quite important in the educational context. Namely, it is crucial for teachers to be informed and familiar with a range of applications ICT offers, in order for ICT to have a significant effect on students' mathematics and science attainment. Therefore, teachers should be digitally competent and supportive. If the way in which teachers use ICT challenges students' thinking, students increase their level of reasoning, attention and activity in class, and, consequently, their subject attainment (Cox & Webb, 2004). Students use ICT for learning more frequently if they are taught by teachers who have high access to ICT equipment in schools, and are also confident in their level of ICT competence (European Commission, 2013).

Although the study by Gillen et al. (2008) revealed that the use of interactive whiteboards in primary science education increased students' understanding of complex scientific terms, ultimate conclusions are not warranted. The results of various studies are still inconclusive and more research is needed in the areas of mathematics and science, in order to draw any definite claims about the effect of ICT use on students' attainment in those areas. However, when comparing the effects of different types of equipment, it is reasonable to assume that devices which allow interactive use will be more effective that those that rely on presentation, due to higher students' engagement.

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In line with the above mentioned arguments, we hypothesize that:

I. ICT activities related to school and learning will have statistically significant positive effects on students' general affective and specific learning cognitive outcomes.

II. Digital educational content use that engages students in deep learning will have statistically significant positive effects on students' general affective and specific learning cognitive outcomes.

III. Teachers' and other educational staff's digital competencies will have statistically significant positive effects on students' general affective and specific learning cognitive outcomes.

IV. Interactive classroom use will have statistically significant stronger positive effects on students' general affective and specific learning cognitive outcomes than the presentational classroom use.

4.3. Second Aim

The second aim of our study is to determine the effects of ICT activities undertaken within the pilot project on development of students' digital competencies as well as students' ICT-related attitudes and experiences. The specific aims refer to determining the effects of ICT activities related to school and learning (SA2.1), digital educational content and learning scenarios (SA2.2), development of educational staff's digital competencies (SA2.3), educational processes (SA2.4), and frequency of using specific infrastructure (SA2.5) on students' digital competencies, ICT-related attitudes and experiences. The last specific aim refers to determining the effects of pilot project on development of digital competencies, ICT-related attitudes and experiences of students with special needs (SA2.6).

As previously explained in detail in section 'ICT and students' motivation, attitudes and skills', numerous conducted studies reported on enhanced students' attitudes toward ICT use since the implementation and integration of ICT into teaching and learning (Cox & Abbott, 2004;

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Passey et al., 2003; Underwood, 2006). It was found that ICT use can have a positive effect on students' attitudes toward ICT use and their schoolwork (Passey et al., 2003). In accordance with that, there were many papers that provided evidence which suggested that students' attitudes became more positive since using mobile devices in class (Berson et al., 2012; Murray & Olcese, 2011). Moreover, different authors mentioned that students reported great learning and social benefits from using interactive whiteboards in class (Clemens et al., 2001; Wall et al., 2005). In summary, engagement in school-related ICT activities shifted students' attitudes toward positive end of scale.

When it comes to students' digital competencies, it is reasonable to expect that ICT use will result in their increase. Generally, frequent involment with any activity will bring progress in that activity. Furthermore, as previously mentioned, students who are taught by digitally competent and supportive teachers have the highest frequency of ICT use during lessons (European Commission, 2013). Naturally, since students' confidence in their digital competence is highly dependent on the access to ICT in schools, students who use ICT more frequently have higher levels of digital competences. Students should learn digital competences with the help of innovative methods schools developed to stimulate their advancement. Teachers' digital competences provide opportunities for active, personalized and collaborative learning environments, which can significantly effect the development of students' digital competence (European Commission, 2013).

It has been repeatedly emphasized in the literature that students with special needs can benefit greatly from using ICT in their learning process (Balanskat et al., 2006; Clarke & Svanaes, 2012; Lewis & Neill, 2001). Moreover, according to Lewis and Neill (2001), besides other benefits of ICT use for students with special needs, it was found that their information technology skills developed significantly through the use of ICT in educational activities. Also, in a study which aimed to investigate the benefits of tablet use for students with special needs (Clarke & Svanaes, 2012), students reported positive attitudes and increased self-esteem after they started using tablet computers in class.

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In light of presented findings, we have formulated the following hypotheses:

I.   ICT activities related to school and learning will be statistically significantly related to development of students' digital competencies, and positive shift in their ICT-related attitudes and experiences.

II. Digital educational content use and use of learning scenarios will be statistically significantly related to development of students' digital competencies, and positive shift in their ICT-related attitudes and experiences.

III. Development of educational staff's digital competencies will be statistically significantly related to development of students' digital competencies, and positive shift in their ICT-related attitudes and experiences.

IV. The implementation of educational processes developed within the pilot project will be statistically significantly related to development of students' digital competencies, and positive shift in their ICT-related attitudes and experiences.

V.   Frequency of using specific infrastructure will be statistically significantly related to development of students' digital competencies, and positive shift in their ICT-related attitudes and experiences.

VI. Activities included in the pilot project will be statistically significantly related to development of digital competencies, and positive shift of ICT-related attitudes and experiences of students with special needs.

4.4. Third Aim

The third aim of the study is to determine the effects of ICT activities undertaken within the pilot project on development of teachers and other educational staff's digital competencies, ICT-related attitudes and experiences. Seven specific aims refer to determining the effects of ICT activities related to school and learning (SA3.1), digital educational content and learning scenarios (SA3.2), trainings for improving digital competencies (SA3.3), communities of practice (SA3.4), educational processes (SA3.5), specific infrastructure use (SA3.6), and of

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some elements of System of digitally mature schools (SA3.7) on educational staff's digital competencies, ICT-related attitudes and experiences.

As previously mentioned in the section 'ICT and Teachers' Perceptions and Attitudes', numerous studies have provided evidence that teachers changed their attitudes toward ICT use after they started using ICT in their teaching and learning activities (Cox & Webb, 2004; Pedersen, 2006). Some common benefits which teachers perceived after integrating ICT in their teaching process are related to immediate feedback on students' activities, facilitating students' understanding of complex terms, better control over the teaching and learning process, etc. (Cox & Webb, 2004; Heitink et al., 2016). Moreover, teachers often perceived great benefits in using interactive whiteboards, considering it can help students' problem-based learning and research activities (Cox & Webb, 2004). It is, therefore, reasonable to assume that engagement in school-related ICT activities will have a significant positive effect on teachers' attitudes toward ICT use.

Concerning teachers' digital competencies, in many studies they have been related to teachers' actual use of ICT in teaching and learning (Balanskat et al., 2006; Buabeng-Andoh, 2012). It is quite intuitive to assume that teachers' digital competencies, as well as their confidence in using ICT will significantly develop as a result of frequent ICT use in teaching and learning. Furthermore, according to Ertmer (2005), teachers change their attitudes and beliefs about ICT by interacting with their peers and colleagues. Moreover, if teachers have time to explore new tools and ICT-based activities with their colleagues, it is more likely that they will gain skills and competencies, and observe the examples of good teaching practice (Petko et al., 2015). Technological process provides opportunities for developing on-line communities of practice, which facilitate the inclusion of participants from a large territory and access to digital tools and materials, as well as their development (Bakia et al., 2011).

As previously explained in the section 'Appropriateness of Teacher Training', numerous authors agree that teacher training can stimulate positive changes in teachers' attitudes, competences, knowledge and skills related to ICT use in teaching (Balanskat et al., 2006; Buabeng-Andoh, 2012; Dhir et al., 2013). However, since professional development was not

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always found to be important to increase ICT use (Hutchinson & Reinking, 2011), it is essential for teacher training and professional development opportunities to be adequate and done properly.

Considering previously mentioned findings and arguments, we hypothesise that:

I. ICT activities related to school and learning will be statistically significantly related to development of educational staff's digital competencies, and positive shift in their ICT-related attitudes and experiences.

II. Digital educational content use and use of learning scenarios will be statistically significantly related to development of teachers' digital competencies, and positive shift in their ICT-related attitudes and experiences.

III. Trainings for improving digital competencies of teachers and other educational staff will be statistically significantly related to development of educational staff's digital competencies, and positive shift in their ICT-related attitudes and experiences.

IV. Communities of practice developed within the pilot project will be statistically significantly related to development of educational staff's digital competencies, and positive shift in their ICT-related attitudes and experiences.

V. The implementation of educational processes developed within the pilot project will be statistically significantly related to development of educational staff's digital competencies, and positive shift in their ICT-related attitudes and experiences.

VI. Frequency of using specific infrastructure will be statistically significantly related to development of educational staff's digital competencies, and positive shift in their ICT-related attitudes and experiences.

VII. Implementing the elements of System of digitally mature schools will be statistically significantly related to development of educational staff's digital competencies, and positive shift in their ICT-related attitudes and experiences.

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4.5. Fourth Aim

The fourth aim of our study is to determine the effects of ICT activities undertaken within the pilot project on development of administration staff's digital competencies, ICT-related attitudes and experiences. Additional specific aims refer to determining the relationship of specific infrastructure use (SA4.1), bussiness processes (SA4.2), and trainings for improving digital competencies (SA4.3) with administration staff's digital competencies, ICT-related attitudes and experiences.

Administrative staff is increasingly expected to be familiar with and use ICT in their work on every-day basis. Consequently, besides teachers, they are also expected to have developed digital competencies. However, there are virtually no studies which aim to empirically test digital competencies, ICT-related attitudes and experiences of administrative staff. In this context the leading researches refer to the role of school leaders, i.e. headmasters. Namely, the educational potential of ICT cannot be fully realized without their support. The crucial role of headmasters in innovation implementation has been known for a long time (Fullan, 1991). Therefore, it is necessary that they take responsibility and make decisions related to use and integration of ICT in learning, teaching, and school management. In other words, they are expected to be agents of change. In his qualitative study, Schiller (2002) showed that headmasters' interventions which aimed at innovation implementation, helped the teachers to integrate ICT into their lessons. These interventions included support, providing help, modelling, training, supervision, collaboration, creating and transfering vision and clear expectations about ICT use in classrooms. Furthermore, Papaioannou and Charalambous (2011) used quantitative methods and large sample of headmasters from Cyprus to show that they usually have positive attitudes toward ICT. However, it is dependent on gender, experience, academic qualifications, home access to computer and Internet, proffessional training for ICT use in teaching, access to computer in office and general experience with computer use. Similarly, Afshari, Abubakar, Wong, and Afshari (2010) claim that headmasters will be able to implement the innovation only if they themselves understand the value and usefulness of ICT. Their results from the sample of Iranian high-school headmasters indicate

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that the majority has only moderate levels of computer expertise and digital literacy. Therefore, the authors concluded that primarily the headmasters need to acquire knowledge and skills for ICT use in order to promote school culture that encourages exploration of new technologies in teaching, learning, and school-management. Tondeur, van Keer, van Braak, and Valcke (2008) inquired the internal policies of Belgian elementary schools related to ICT integration focusing on both teachers' and headmasters' perspectives. That is, they aimed at determining the relationship between school ICT policy and actual ICT use in lessons. The results showed that ICT school policies (manifested through planning, support, and training) had a significant effect on actual ICT use. Using a large sample of public schools in Italy, Polizzi (2011) studied the predictors of headmaster's support to ICT integration into lessons and bussiness processes. The results show that headmaster's support depends on two types of variables – contextual and individual. The former (contextual) included the available budget for ICT infrastructure, the level of teachers' digital competencies, frequency of use, and teachers' attitudes toward ICT integration. The latter (individual) variables included headmaster's attitudes toward ICT integration, their exposure to ICT training, and their perceived digital competencies.

This modest review of selected findings from different school systems and social environments supports the importance of attitudes, experiences, and digital competencies of administrative staff in the course of ICT implementation into school's educational and bussiness processes. Due to lack of relevant studies, in terms of our specific research aims, we do not have the empirical basis for forming hypotheses. However, there is no reason to assume that the effects for this group will be different from the effects we expect in the teachers' subsample. In line with this reasoning, we formulated the following hypotheses:

I. Specific infrastructure use will be statistically significantly and positively related to administration staff's digital competencies, ICT-related attitudes and experiences.

II. Bussiness processes developed as part of the pilot project will be statistically significantly and positively related to administration staff's digital competencies, ICT-related attitudes and experiences.

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III. Trainings for improvement of digital competencies will be statistically significantly related to development of administration staff's digital competencies, and positive shift in their ICT-related attitudes and experiences.

4.6. Fifth Aim

The fifth and final aim of this study is to determine the effects of pilot project on schools' level of digital maturity in terms of Digital Maturity Framework. The specific aims refer to determining the relationship of schools' digital maturity with ICT use (SA5.1), digital educational content use and use of learning scenarios (SA5.2), trainings (SA5.3), development of communities of practice (SA5.4), educational and bussiness processes (SA5.5), ICT infrastructure (SA5.6), and ICT application management (SA5.7).

Empirical studies which would provide evidence for formulation of our research hypotheses are missing. However, certain predictions can be made based on the nature of digital maturity construct. Namely, as was presented in the 'Introduction', basically all predicting variables included in the fifth aim are already incorporated into the Digital Maturity Framework. Namely, ICT and digital educational content use are elements from the 'ICT in teaching and learning' area, trainings from 'Development of digital competences', educational and bussiness processes from 'Leadership, planning and management', while ICT infrastructure and ICT application management are elements from ' ICT resources and infrastructure ' area. In other words, nearly all predicting variables can be mapped onto elements from the Digital Maturity Framework. That implies that any intervention into any of these variables will necessarily affect the level of schools' digital maturity. Therefore, we formulated the following hypotheses:

I. ICT use will be statistically significantly positively related to school's level of digital maturity.

II. Digital educational content use and use of learning scenarios will be statistically significantly positively related to school's level of digital maturity.

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III.   Professional development trainings will be statistically significantly related to an increase in school's level of digital maturity.

IV.   Development of communities of practice will be statistically significantly related to an increase in school's level of digital maturity.

V.   Implementation of educational and business processes will be statistically significantly related to an increase in school's level of digital maturity.

VI.   ICT infrastructure implementation will be statistically significantly related to an increase in school's level of digital maturity.

VII.   Appropriate ICT application management will be statistically significantly related to an increase in school's level of digital maturity.

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5. THE BASIC METHODOLOGY OF THE RESEARCH

The proposed research examines the effect of the pilot project on the three basic groups of outcomes:

1. General and specific learning outcomes,
2. Digital competences, attitudes and experiences of students, educational and administrative staff, and
3. Level of digital maturity of schools in general.

In doing so, quantitative methods are mostly used, while qualitative research is planned only for a specific goal 2.6. *(To examine the effect of the implementation of the Pilot project on (1) the development of the digital competence of students with disabilities, and (2) their attitudes and experiences related to ICT.).* The main method of data collection is through various on-line questionnaires, followed by evaluation of the specific cognitive outcomes and specific problem solving tasks which assess digital competences (of students, educational and administrative staff). Qualitative methods such as focus groups will be used only in Centre for education Krapinske Toplice. Every research method was selected to best fit the set goal, i.e. the problem of research.

5.2. The Main Objectives of the Research

The study is divided into five main goals, through which the effect of the individual sub-elements of the project on the main research constructs is verified. The main research constructs are general and specific learning outcomes (*general goal 1*), digital competences, attitudes and behaviour of students (*general goal 2*), educational (*general goal 3*) and administrative staff (*general goal 4*), and the level of digital maturity of schools generally (*general goal 5*). For each of the major research constructs, adequate measures for their assessment were developed. Also, since the effects of different e-Schools project's sub-elements on research constructs were evaluated, measurement instruments and procedures

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for the verification and control of sub-elements of the project were also developed. Below are the instruments for main research constructs (Table 4), and sub-elements of the project (Table 5). Table 4 shows the relationship of the main research construct and sub-elements of the project which will be evaluated in this study.

Table 4. *Sub-elements of the Project in Relation to the Main Research Constructs*

	GOALS:	1	2	3	4	5
Sub-elements	**Main Research Constructs**	General Affective and Specific Cognitive Outcomes	Digital Competences, Attitudes, and Experiences Of Students	Digital Competences, Attitudes, and Experiences of Educational Staff	Digital Competences, Attitudes, And Experiences of Administrative Staff	Level of Digital Maturity of Schools
A	Adequate ICT Infrastructure	X	X	X	X	X
B	Improved Business and Teaching Processes		X	X	X	X
C	Application of The System of Digitally Mature Schools			X		X
D	The Use of ICT And DEC in the Educational Process	X	X	X		X
E	Developing a Community of Practitioners			X		X
F	Improving Digital Competences of the Educational and Administrative Staff	X	X	X	X	X

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## 5.3. Measurement Instruments According to the Main Research Constructs

Based on the review of scientific literature and analysis of the questionnaires which were used in the *Pilot-20 ("The first phase of the research of the effects of the pilot project e-Schools in 20 selected schools: Learning outcomes, competences, attitudes, and experiences of students and teachers"*) new measuring instruments have been developed or existing ones were adapted. Research *Pilot-20* was conducted by the Center for Applied Psychology at the University of Rijeka, in order to enable systematic monitoring and evaluation of the effects of the project "e-Schools: Establishing a system of development of digitally mature schools", based on data collected.

5.3.1. General and Specific Learning Outcomes (General Goal 1)

Learning outcomes are competences which a person has acquired through learning and demonstrated after the learning process, while the competences are knowledge and skills along with the associated autonomy and responsibility (Law on the Croatian Qualifications Framework, CROQF, NN 22/13). We can distinguish the general outcomes, which include the affective component, and specific outcomes, i.e. specific knowledge and skills (specific competencies) which students have acquired during the learning process, and demonstrated after learning.

General affective outcomes will be measured by different motivation and affect questionnaires. Affective outcomes for the specific class activities (learning scenarios) will be assessed within each class.

Specific cognitive outcomes will be measured through tasks which will assess the achievement of the planned cognitive outcomes (e.g. essay tasks, objective assessment, problem-solving tasks and/or practical tasks). The content of these tasks will be defined and aligned afterwards with respect to ICT activities which will be used in the classroom (especially for the learning scenarios). To test specific cognitive outcomes cooperation with teachers who apply certain

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ICT activities (e.g. specific learning scenarios) will be necessary in order to check whether the outcomes achieved are those which were defined by this activity.

5.3.2. Digital Competences, Attitudes and Experiences (General Goal 2, 3 and 4)

Furthermore, it is necessary to check the effects of the e-Schools Project on digital competences, attitudes, and experiences of students, educational and administrative staff.

a. Digital Competences

According to the *Framework for the Digital Competence of Beneficiaries in School*, digital competence can be broadly defined as a confident, critical and creative use of digital technologies in order to achieve objectives related to business, education, leisure, increase employability and participation in society. It is described as a reliable and critical use of technology in the information society, which includes basic skills in using informational and communicational technologies (Žuvić et al., 2016, p. 5).

In this study, digital competences will be tested in two ways, through self-assessment, and solving some specific problem-solving tasks.

Based on the review of scientific literature and available frameworks for the development of digital competences, the *Self-Assessment of Digital Competences Questionnaire* was developed. The Questionnaire covers all five areas proposed by the Framework, which comprise the *general digital competences*. These are information and data literacy, communication and collaboration, content creation, self-confidence and problem-solving. Each of these areas covers several specific competencies. Although all digital competences within the Framework are recognized on three levels of complexity: foundation, intermediate and advanced, in the Questionnaire has been added a possibility that the subject did not develop a specific digital competence. For each competence in the Questionnaire we used rubrics to describe in detail each of

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the level of development (not developed, foundation, intermediate, advanced) and each participant should mark for each of the 21 items the level of competence they have, on a Likert scale of 4 degrees.

This questionnaire measures self-assessment of the *general digital competences* of educational (including teachers and professional staff at school) and administrative staff (including headmasters and administrative staff), and students.

Questionnaire for students will follow the same *Digital Competence Framework* and the list of competences, which will be described in a manner adapted to the students' age, and will include the assessment of the general digital competences.

In addition to general digital competences, teachers will also fill out the *Self-Assessment of Digital Competencies Specific for the Application of Digital Technology in Education Questionnaire*. Competences for the application of digital technology in education are elaborated through three areas: using digital technology for teaching and learning, working in the school environment, and professional education and lifelong learning. This questionnaire will be developed in the same way as the *General Questionnaire of Digital Competences* and teachers will, for 11 different competences on a scale of 4 degrees (not developed, foundation, intermediate and advanced level) mark the estimated extent to which they have developed a certain competence that is important for the application of digital technology in education.

Headmasters will fill out an additional questionnaire relating to specific digital competences which correspond to school management. Digital competences for school management are elaborated through one area - *planning and management*. Similar to the teachers' questionnaire, in this questionnaire headmasters will on 12 items (which describe certain competences related to planning and management) on a scale of 4 degrees (not developed, foundation, intermediate and advanced level) mark the estimated extent to which they have developed a certain competence that is important for the application of digital technology in school management.

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In addition to self-assessment of digital competences, specific digital competence of the educational and administrative staff and students will be tested. The measurement of specific digital competence will be carried out through a variety of different tasks. Tasks for the measurement of specific digital competences of the *educational and administrative staff* will be linked with educations for improvement of digital competences, and defined in accordance with the outcomes of educations. Tasks for the measurement of specific digital competences of *students* will be associated with certain outcomes of individual teaching topics and learning scenarios used.

b. The Attitudes and Experiences with ICT Use

The attitudes and experiences that are associated with the educational and administrative staff's and students' use of ICT will be tested through on-line questionnaires. Questionnaires were developed for this study based on the review of scientific literature, and adapted according to the instruments used in the *Pilot-20*.

Educational staff and students will fill out questionnaires which examine their attitudes towards the use of ICT. These attitudes will be examined in terms of the perceived benefits and risks for ICT use in general (unrelated to the school) (e.g. *On the Internet, students learn new and useful content*. or *Due to too frequent use of ICT, students do not socialize enough with parents and friends*), as well as the advantages and risk for ICT use in learning and teaching (e.g. *Students are putting more effort into what they are learning*. or *ICT in class distracts students from the material that is being taught*.). It will also provide information on the availability and frequency of use of computer equipment (at home and at school). In addition to the reasons for using ICT in everyday life (e.g. *I'm looking for entertaining content*.), the reasons for using ICT related to education and learning (e.g. *I'm looking for content that can help me with homework, seminal papers or obligatory reading material*.) will be examined for the students. They will also answer additional questions about the perception of the feeling of being in

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the state of flow during the use of ICT (e.g. *When I work with ICT, I tend to ignore everything around me*).

With teachers, the reasons for using ICT in education and teaching (*Preparation and realization of teaching, Communication with parents and students, Education and Training*) and the types of learning activities for which they would use ICT (e.g. *Practicing skills and strengthening knowledge, browsing additional sources of information on the Internet, problem-solving*) will be further examined. Teachers will further evaluate the possible obstacles in the use of ICT in teaching and learning – either external (e.g., *lack of equipment and support*), or internal (e.g., *teachers are not motivated and have difficulties in integrating the use of ICT in the curriculum*) obstacles. They will fill a questionnaire that examines the climate within their schools related to the use of ICT (e.g. *We are constantly innovating the use of ICT for education in our school.*), as well as questionnaires on professional training in the field of ICT, use, development and publication of digital teaching materials, and knowledge and perception of learning scenarios, a repository of educational materials, and community of practitioners. Teachers will assess their personal beliefs about learning and teaching, including the assessment of goal orientations which they encourage in their students and their approaches to teaching. The goal orientations questionnaire will examine to what extent the teachers encourage the students' mastery orientation (e.g. *I want my students to understand the material, not only to do what is necessary.*), and to what extent are they performance-oriented (e.g. *I emphasize the importance of achieving good grades to my students.*).

Two basic approaches to teaching will be examined: teacher-centered and student-centered, where teachers will demonstrate whether they orient more towards the transfer of knowledge and demonstration of skills by presenting the content (e.g. *If the teacher does not encourage students and does not direct them, they themselves will not find the right answer.*), or towards encouraging active learning among students and

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their independent review of their understanding of teaching materials (e.g. *Students learn best when they independently look for solutions to different problems*.).

The assessment of students' motivation and affect will relate to the sciences and mathematics school subjects area. Achievement goal orientations as students' reasons for engaging in learning activities in these subjects will be examined. Mastery goal orientation reflects the students' focus on understanding, gaining knowledge and developing competence (e.g. *For me, an important goal in studying is to acquire new knowledge*.), while the performance goal orientation refers to the students' desire to demonstrate their competence in comparison with others (e.g. *It is important to me that others think I'm able and competent*.). Self-reports on work avoidance goal orientation reflect the extent to which students focus on avoiding challenges and minimizing effort in achievement situations (e.g. *I try to get off with my schoolwork with as little effort as possible*.). Besides achievement goal orientations, other students' motivational beliefs such as causality and agency beliefs will be investigated. Students will be asked to evaluate the relevance of effort (e.g. *You succeed in studying, if you just try enough*.), ability (e.g. *One does not learn things taught in class, if he/she is not smart enough*.) and luck (e.g. *If one does well in tests or tasks, it is due to good luck*.) as potential causes for success and failure in the examined school subjects. They will also assess the extent to which they believe that they possess the means needed for success in these school subjects: effort (e.g. *I work hard to succeed*.) and ability (e.g. *I do have the abilities needed for learning*.). In addition, students will rate their own competence as well as the importance, interestingness and difficulty in relation to each of the given school subjects (physics, biology, chemistry and mathematics). In order to examine the emotions experienced by students when being in sciences and mathematics school subjects class, the questionnaire on several positive and negative class-related emotions will be administered: enjoyment (e.g. *I am happy that I understood the material*.), pride (e.g. *I think that I can be proud of what I know about this subject*.), anger (e.g. *Thinking about all the useless things I have to learn makes me*

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irritated.), anxiety (e.g. *I worry whether the demands might be too great*.), hopelessness (e.g. *It's pointless to prepare for class since I don't understand the material anyway*.) and boredom (e.g. *I'm tempted to walk out of the lecture because it is so boring*.).

Administrative staff's attitudes towards the use of ICT (in general and in relation to their job) will be tested through an on-line questionnaire, which was developed and customized based on the questionnaire for the survey of attitudes of the educational staff. The main reasons for their use of ICT related to the operations and management of schools (e.g. *I collect information which are important for my job in school*.), as well as the frequency of use of specific programs (e.g. *Centralized payroll system, Accounting software, Data archiving system*) will be examined. Also, the perception of the main advantages (e.g. *Due to ICT, I am more easily doing the administrative part of the job*.), as well as risks (for example, *I find it difficult to integrate ICT into my daily work*.) of introducing the ICT into business processes will be examined. The climate for ICT at school (e.g. *At school we share knowledge and experiences on the use of ICT in teaching/business*.) will be further examined.

Headmasters will also fill out on-line questionnaires through which their attitudes on the use of ICT will be examined. The questionnaires include checking the availability and frequency of use of different equipment at home and at school, the most common reasons to use the school- and teaching-related ICT (e.g. *I browse for and/or participate in on-line training programs*.). Similar to the teachers, headmasters will also be asked to express their opinion on the use of ICT among students in general, and not only school-related (e.g. *On the Internet, students learn new and useful content.; Because of ICT, students neglect their school work*.) i.e. their opinions on the introduction of ICT in teaching (e.g. *ICT makes it easier for me to work on new tasks.; With the introduction of ICT, I got a lot of new tasks which I did not have before*). Also, possible obstacles to the use of ICT in learning and teaching (e.g. *Insufficient ICT equipment in schools; Lack of interest among teachers*.), as well as the climate for ICT in their school (e.g. *At school,*

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we are committed to the introduction of ICT in education /school management) will be evaluated.

Within the evaluation of the main research constructs, it is necessary to further examine *digital competence, attitudes and experiences related to ICT among students with disabilities* (goal 2.6). This part of the research will be carried out at the Centre for Education Krapinske Toplice, and will be achieved through qualitative research methods, mainly through focus groups and interviews with teachers. The manner of evaluating digital competences, attitudes and experiences of students with disabilities will be adjusted to the type and level of their disability. When designing the best way to evaluate the mentioned constructs in students, experts with experience in working with children with disabilities will be consulted.

5.3.3. The Level of Digital Maturity of Schools in General (General Goal 5)

Digitally mature school, as defined in the framework of the e-Schools program, are schools on a high level of integration of ICT in their life and work. Digitally mature schools have a systematized approach to ICT use in schools planning and management, as well as in their educational and business processes. They have adequately equipped classrooms and offices, as well as staff and students, with ICT equipment. They have a systematic approach to the development of digital competence of educational staff and students, and the educational staff uses ICT to improve their teaching styles to focus on students, development of digital educational content and evaluation of students' achievements, in accordance with the learning outcomes and educational objectives (CARNet, 2016).

Digital maturity of schools will be tested in two ways: through self-evaluation and external evaluation. Evaluation of digital maturity of schools is part of a separate project, which aims to develop a framework for digital maturity of schools, as well as other elements of the system for digital maturity of schools, as a part of the pilot project e-Schools, and is carried out by the Faculty of Organization and Informatics, in co-operation with Croatan Academic and research network (CARNet).

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For the achievement of the fifth goal of the research, the research team will need to obtain the data regarding self-evaluation and external evaluation of the digital maturity of each school. The planned research will link the collected information about digital maturity of schools (obtained self-evaluation and external evaluation) with all tested constructs and sub-elements of the project, in accordance with the set general and specific goals. All data collected in this study will be compared to the level of digital maturity of the school, in order to monitor possible changes in the level of digital maturity of schools.

Table 5 gives an overview of all the measurement instruments for the main research constructs, according to the general goals of the project.

Table 5. *Measurement Instruments for Major Research Constructs According to the Defined General Goals of the Project*

General Goals of the Research	Main Research Constructs	Measurement Instruments
1	General affective learning outcome	Academic emotion questionnaire
	Specific cognitive learning outcome	Tasks to verify the achievement of specific cognitive outcomes
2	Digital competences of students	Questionnaire of digital competences for students; Performance tasks for evaluating digital competences of students
	ICT-related attitudes and experiences of students	*Questionnaires about:* Availability of ICT devices at home; Frequency of use ICT devices at home; Availability of ICT equipment in schools; Frequency of use of ICT equipment in schools; Reasons for the use of ICT in everyday life (unrelated to school); Reasons for the use of ICT in education and teaching; Attitude towards the use of ICT in general; Attitude towards the use of ICT in teaching and learning; Motivational variables *(1. Goal orientations; 2. Causality beliefs; 3. Agency beliefs; 4. Competence and importance, interest and difficulty in relation to each of the given school subjects);* Academic emotion questionnaire; The flow in the use of ICT;
	ICT-related digital competences, attitudes and experiences in students with developmental disabilities	Qualitative research methods (focus groups, observation method and (semi)structured interviews with teachers and possibly parents)

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General Goals of the Research	Main Research Constructs	Measurement Instruments
3	Digital competences of educational staff	Questionnaire of general digital competences of educational staff; Questionnaire of specific digital competences for learning and teaching of teachers; Performance tasks for evaluating digital competences of teachers
	ICT-related attitudes and experiences of teachers	*Questionnaires about:* Availability of ICT devices at home; Frequency of use ICT devices at home; Availability of ICT equipment in schools; Frequency of use of ICT equipment in schools; Reasons for the use of ICT in everyday life (unrelated to school); Reasons for the use of ICT in education and teaching; Attitude towards the use of ICT in general; Types of students' ICT activities in school; Students' attitude towards the use of ICT (unrelated to school); Attitude towards the use of ICT in education and teaching; ICT climate in school; Obstacles to using ICT in school; Expectations and teaching approaches; *(1. Goal orientations; 2. Teaching approaches)*; Questionnaire on professional training in the field of ICT
	ICT-related attitudes and experiences of professional staff	*Questionnaires about:* Availability of ICT devices at home; Frequency of use ICT devices at home; Availability of ICT equipment in schools; Frequency of use of ICT equipment in schools; Reasons for the use of ICT in education and teaching; Students' attitudes towards the use of ICT in general (unrelated to school); Attitude towards the use of ICT in education and teaching; ICT climate in school
4	Digital competences of administrative staff and headmasters	Questionnaire of (general) digital competences of administrative staff and headmasters; Questionnaire of (specific) digital competences for planning and school management, for headmasters; Performance tasks for evaluating digital competences of administrative staff

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General Goals of the Research	Main Research Constructs	Measurement Instruments
	ICT-related attitudes and experiences of administrative staff	*Questionnaires about:* Availability of ICT devices at home; Frequency of use ICT devices at home; Availability of ICT equipment in schools; Frequency of use of ICT equipment in schools; Reasons for the use of ICT related to work and school management; Attitude towards the use of ICT in education and teaching; ICT climate in school
	ICT-related attitudes and experiences of headmasters	*Questionnaires about:* Availability of ICT devices at home; Frequency of use ICT devices at home; Availability of ICT equipment in schools; Frequency of use of ICT equipment in schools; Reasons for the use of ICT related to education and teaching; Students' attitude towards the use of ICT in general (unrelated to school); Attitude towards the use of ICT in education and teaching; Obstacles to using ICT in school; ICT climate in school
5	The results of schools regarding the Framework for the Digital Maturity of Schools	Information about digital maturity of schools (self-evaluation and external evaluation)

5.4. Measurement Instruments According to the Sub-elements of the Project

As it was already pointed out, the proposed scientific research examines the effect of the Pilot project on several of the dependent variables. Since it is a very complex project, it was divided into several sub-elements in order to examine their effects. These are: (a) adequate infrastructure, (b) improved business and educational processes, (c) the application of systems of digitally mature schools, (d) the application of ICT and DEC in the educational process, (e) development of community of practitioners, and (f) improvement of digital competences of the educational and administrative staff.

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5.4.1. Adequate Infrastructure (Sub-element A)

Through the e-School project, it is planned to build a network, equip schools and employees, and establish adequate data centers and a network of regional training centers. It is also planned to equip classrooms (informational and presentational), as well as to equip teachers and administrative staff with computers (including hybrid PCs, notebooks, PCs and tablets). The available data on infrastructure shall be collected continuously throughout the study, from all relevant stakeholders (school headmasters, educational and administrative staff), so that these data can be compared with the main research constructs and set goals of the research.

5.4.2. Establishing the Improved, Transparent and Related (Business) and Educational Processes (Sub-element B)

This sub-element includes security of services, sensors and smart management, system for managing the classroom, ecosystem of e-School services, applications for organization of educations, a repository of digital learning materials, learning analytics system and newly developed services for school management. It will be examined how well the educational and administrative staff knows and uses existing and new teaching and business processes. Also, data will be collected on how much has been achieved of the planned introduction of new processes. This data will then be analyzed and linked to relevant research constructs, according to the research plan.

5.4.3. Application of the System of Digitally Mature Schools (Sub-element C)

The framework for digital maturity of schools is theoretical; it was developed on the basis of the existing framework and adapted to Croatian school system, which serves as a basis for assessment of the digital maturity of schools. It was developed by the Faculty of Organization and Informatics in Varaždin, University of Zagreb, in co-operation with Croatan Academic and research network (CARNet) within the project e-Schools. All schools participating in the e-

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Schools project will participate in self-evaluation and external evaluation of digital maturity, at the beginning and at the end of the project. These data about digital maturity of school (at the beginning and at the end of the project) will be linked with other relevant constructs. This sub-element of the e-Schools Project also includes development of school teams which will develop and implement a strategy for their school, which will also be controlled in the final measuring of the planned research.

5.4.4. The Use of ICT and DEC in the Educational Process (Sub-element D)

During the e-Schools project, it is planned to develop 16 comprehensive digital educational contents (DEC), one for each of the following subjects - mathematics, physics, biology and chemistry, for each of the 4 levels (7th, 8th, 1st and 2nd grade). Each of the 16 planned digital educational content (DEC) involves development of the entire curriculum of a particular subject for a particular grade. It is also planned to develop 240 learning scenarios, e-reading (website) and e-lab (available digital tools) during the e-Schools project. Teachers can use learning scenarios for specific topics within DEC for particular subject. Within this research it is planned to examine the effects of the 16 learning scenarios (one for each of the four subjects and for each grade). A detailed method of checking the effects of the application of learning scenarios is shown in part *Specific measurement procedures*.

5.4.5. Developing a Community of Practitioners (Sub-element E)

In this sub-element, it is planned to develop a community of practitioners, or virtual community of school employees, which would aim to connect teachers and enable them to communicate and share examples of the best practices of using ICT in education. Community of practitioners is planned to be realised through the platform of Yammer network. The effects of the sub-elements will be examined through the analysis of available data from Yammer network, in cooperation with experts from the Croatian Academic and Research Network (CARNet).

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5.4.6. Improving Digital Competences of the Employees (Sub-element F)

During the project trainings aimed at increasing digital competences of employees will be organised, in order to eventually increase the digital maturity of the schools as a result. Trainings will be organised for all employees (teachers, professional and administrative staff). The effects of this sub-element will be tested in two ways. Through the questionnaires, it will be controlled which employees participated in the training, which trainings have they completed, duration and the program of the training, and the like. These data will be then connected with the corresponding research constructs. Since the educations aim at increasing digital competences of employees, a small number of educations will be checked for their effect on digital competences measured through performance tasks. A detailed method for verifying the effects of trainings is shown in part *Specific measurement procedures*.

Measures for all sub-elements of the project are shown in Table 6.

Table 6. *Measurement Instruments for Specific Constructs Defined According to Sub-elements of Research*

Sub-element	Main Research Constructs	Measurement Instruments
a	Adequate ICT infrastructure	Diary of the use of adequate ICT infrastructure in education for every teacher Questionnaire on the use of appropriate ICT infrastructure for professional and administrative staff, and headmasters Questionnaire of realisation of the project's goals - data on the existing ICT infrastructure in schools
b	Improved business and educational processes	Journal for administrative staff of the use of new business processes and their suitability Questionnaire of realisation of the project's goals - information on new business and learning processes in schools
c	Application of systems of digitally mature schools	Data on self-evaluation and external evaluation of digital maturity of schools from other sources
d	Application of ICT and DEC in the educational process	Questionnaire for students to examine the frequency of use of various school- and learning-related ICT activities The questionnaire for teachers to examine the frequency of use of various school- and learning-related ICT activities Diary on the frequency of use of learning scenarios by teachers
e	Development of community of practitioners	The questionnaire for teachers on establishing a community of practitioners, its availability and suitability Questionnaire on realisation of the project's goals - data on the development and availability of community of practitioners

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Sub-element	Main Research Constructs	Measurement Instruments
f	Improvement of digital competences of the educational and administrative staff	The questionnaire for educational staff - self-assessment of the trainings, its adequacy and applicability to work with ICT Questionnaire on realisation of the project's goals – control of the number and quality of educations which teachers and administrative staff of individual school have successfully completed

5.5. Specific Measurement Procedures

In addition to questionnaires, some major research constructs, sub-elements of the project, and the specific samples of subjects will be tested through very specific measures. This primarily refers to the examination of the effects of improving digital competences of employees (sub-element f), evaluation of application of DEC and learning scenarios (sub-element d), then the specific major research constructs (cognitive outcomes and digital competences), and research methods with students and teachers of the Center for Education Krapinske Toplice.

5.5.1. Improving Digital Competences of Employees

Improving digital competences of teachers will be tested in two ways: through the on-line questionnaire and examination of the effects of educations. Participation of teachers in educations (e.g. type of education, duration) will be checked through the on-line questionnaire, and the effects of education will be examined through the implementation of performance tasks and analysis of the results. The effects of three educations will be examined in detail: 1. *Basics of the tablets and hybrid computers use*, 2. *Application of tools for creating digital learning content* and 3. *Application of learning scenarios, digital tools and educational trends*. These educations were chosen because they represent the essential use of technology. In order to check the effects of the training, participants will have to solve certain tasks before and immediately after each workshop. Tasks will be designed by the research team, according to the proposed content of education and the intended outcomes. Also, different types of tasks will be included, such as objective type tasks, but also problem-solving tasks. If available, data collected by the holder of the educations will be included. In addition to solving

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performance tasks, in the evaluation of education *Application of tools for creating digital learning content* and *Application of learning scenarios, digital tools and educational trends*, participants' final work will be evaluated. Since for these two workshops it is planned for participants to make a small digital content using the appropriate tool, and to develop one teaching scenario and instructions for its use, the research team will evaluate the final work of workshop participants. The research team, in cooperation with experts in the field (e.g. Department of Informatics, University of Rijeka, or Faculty of Organization and Informatics in Varaždin University of Zagreb), will create and define the criteria against which to evaluate the final work of the participants of the educations. Since these are very specific measures, in this part of the study a small number of teachers will participate. In a manner previously described, the effects of the selected three trainings with two (or three) groups of participants (expected number of participants is between 20 and 25 per group) will be checked. In this way, it is planned to include approximately 120 teachers, who will solve certain tasks before and after training (planned for all three education), of which 80 of them will participate in the evaluation of the final work (planned for two training).

5.5.2. Evaluation of the Application of DEC and Learning Scenarios

Following the evaluation of the effects of *Application of learning scenarios, digital tools and educational trends* training, with the teachers who participated in the workshop the effects of the application of learning scenarios in the classroom will be examined. Of the teachers who participated in the evaluation of the effects of the training, (tasks for knowledge assessment + evaluation of the final work) will be selected those teachers who can apply in their schools learning scenario for the same unit onto four classes - two (experimental) classes using ICT, and two (control) classes, where the same teaching unit will be presented in the traditional manner, without learning scenario and ICT. This will be a way to check the effects of the application of learning scenarios to all four subjects of natural sciences areas (mathematics, physics, chemistry and biology), for all four grades (7th and 8th elementary school and 1st and 2nd high school). In close collaboration with the school coordinators, 16 teachers will be

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selected (one teacher for each subject and each grade) to be examined for the effects of application of learning scenarios as described above. Each of the selected teachers will present one unit, using the learning scenario of (in two parallel classes - experimental) and the same unit in the traditional manner, without the use of learning scenarios (also in two parallel classes - control). In this way, the total of 64 classes will be covered - 32 classes in which learning scenarios will be used, and 32 classes in which the material will be presented in the traditional manner, without the use of learning scenarios. In addition to the 16 teachers who will participate in this quasi-experimental framework of the evaluation of the effects of learning scenarios (who will handle the same teaching unit without the use of learning scenarios), the other part of the teachers who participated in education *Application of learning scenarios, digital tools and educational trends*, which will be evaluated, will participate in one part of the research plan. They will handle the same teaching unit (as teachers in quasi-experimental framework) using a learning scenario in one (experimental) class (i.e., without control classes). Students in all classes (with and without applying the learning scenario) will solve performance tasks which will assess the achievement of cognitive outcomes, depending on the plan of the lesson that is being presented.

5.5.3. Assessing the Specific Cognitive Outcomes

Examining specific cognitive outcomes is closely connected with the use of learning scenarios. As already stated, the achievement of specific cognitive outcomes will be evaluated on the basis of the achievements in the tasks which will students (in specific classes, as explained above) solve before and after presentation of certain specific educational units (whether it was presented with or without learning scenarios). Different types of tasks, such as essay tasks, objective tasks, problem-solving and/or practical tasks, will be used and their content will be adapted to the intended learning outcomes for the presented teaching unit.

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5.5.4. Assessing the Digital Competences through Performance Tasks

Examining the digital competences through performance tasks will be carried out on a small number of teachers and students who participated in the evaluation of training and testing the effects of learning scenarios on cognitive learning outcomes of students.

Examining digital competences of <u>teachers</u> will be linked to examining the effects of the education. Those teachers who participated in the evaluation of the selected trainings, will also participate in this part of the test. In cooperation with the experts in the field, tasks will be created on the basis of which the level of individual digital competence of teachers will be assessed.

Examining digital competences of <u>students</u> will be linked to examining the effects of application of learning scenarios on cognitive learning outcomes. Students who will participate in this part of the research will also have to solve the tasks on the basis of which the level of individual digital competences will be assessed. These tasks will also be developed in collaboration with the experts in the field.

Given the complexity of the examination of these research constructs (digital competences and cognitive outcomes) and sub-elements of the project (the effect of the education and the effect of learning scenario application), it is not possible to implement these specific measurement procedures on the entire sample, rather, in this part of the research a smaller number of teachers and students will participate. For the success of this part of the research, a close cooperation between the Schools coordinators and the research team is crucial. The research team will choose the 40 schools where a more detailed analysis will be conducted, i.e. examination through specific measuring procedures, and not just on-line questionnaire survey (detailed description of the schools' selection criteria is presented in the part *Determining the sample*). Teachers and students will be selected from these 40 schools, i.e. grades which will participate in this part of the research. During the selection of teachers who will participate in the evaluation of the training, it is necessary to close and timely (before the

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training begins!) cooperation with the school coordinators. The school coordinators will have to direct the research team towards the teachers who teach four classes of the same grade (e.g. four seventh grades), because they are crucial for quasi-experimental testing of the effects of learning scenarios. In order to examine the effects of application of learning scenarios on cognitive learning outcomes, it is necessary that these same teachers are participating in the selected training courses which will be evaluated. After participating in the training, teachers from the same area should work together to develop concrete learning scenarios to apply. Also, as their students will participate in the examination of these specific constructs, it is necessary to know in advance which teachers (or classes) are participating, so that all the students in these classes could participate in an on-line questionnaire survey (unlike other classes where a random sample of respondents who will participate in the study will be chosen).

5.5.5. Research at the Center for Education Krapinske Toplice

Given that the school is attended by the students with disabilities, in addition to applying on-line questionnaire survey measures for all educational and administrative staff of the school, implementation of specific qualitative research methods is also planned.

Bearing in mind the possible challenges in the context of self-assessment and evaluation of digital competences of children with disabilities who attend this school, it is planned to use appropriate methods and techniques for collection of qualitative research-specific data. In this regard, it is expected implementation of the focus group, use of the observation methods, (semi)structured interviews with teachers of that school and possibly parents. For each of the methods and techniques, it is planned to develop adequate instrument or protocol, with a written statement of informed consent of the research participants. Depending on the capabilities of students and in collaboration with the school's professional staff, if appropriate, digital competences of the students could be examined through certain performance tasks.

It is planned to form two focus groups, one for the initial and one for the final evaluation. In the focus groups, a considerable emphasis will be put on the following topics: the use of ICT

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in planning and in classroom (both for students and teachers), frequency of use, perceived advantages and disadvantages, and especially examination of the needs for using specialised equipment and programs. (Semi)structured interviews with teachers (and possibly parents) will focus on topics of students' ICT-related attitudes and experiences, frequency of use of ICT activities, and evaluation of teachers (and possibly parents) about digital competences of students.

Since this part of the research involves smaller, purposeful, and information-rich sample, focus groups and interviews will be recorded and then transcribed, and in their analysis method of constant comparison will be used, if necessary, with the software support (MAXQDA 12). Data collected by different methods/techniques will enable development of the case study of the Center for Education Krapinske Toplice.

5.6. Determining the Sample

In the e-Schools project a total of 151 schools is included, 101 of which are elementary and 50 secondary schools. The effects of the project should be checked on the schools as a whole (i.e. organizations), but also specifically on the teachers of science subjects which work in them (about 1,200 people), students of 7th and 8th grade of primary school (approximately 10,500 students), and the first and second grade of secondary school (about 13,500 students). Students with disabilities who are integrated into regular schools should be also included in the sample. In addition, headmasters, professional and administrative staff of the participating schools should be also tested. Since it is a large sample of respondents, the research will be conducted on selected representative sample of students and school employees. In the on-line questionnaire study, a sample of respondents from all 151 schools will participate. Specific measuring procedures (as described above, while describing the evaluation of the learning scenarios outcomes on the effects of cognitive learning outcomes) will be implemented on a small number of schools. The research team has, on the basis of certain conditions which had to be met, chosen schools from which the teachers and students

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who will participate in the specific measurement procedures will come from. Hereinafter the selection of the school is described in detail.

In order to select the 40 schools from which the teachers and classes will be selected to participate in the examination of the effects of application of learning scenarios and digital competences of students and teachers of performance tasks, the primary criteria which were used in this process were location and the size of the school, and its ICT Readiness Index[4]. We have tried to include schools which are located in the cities where Regional Training Centers (RTC) would be, or schools which are located near these cities, in order to efficiently and cost-effectively implement the planned measuring. Furthermore, given the planned comparison of different dependent variables between the classes in which learning scenarios are applied, and those in which these tools are not used, in this sample we did not include small schools (<16 classes) because of the possibility that they would have only one grade in a generation. That would make it impossible to have the control group and would therefore affect the strength of the research and the possibility of making valid conclusions. Thus, the sample includes only schools of optimum size (16 to 20 classes) and high schools (> 20 classes). The sample of the selected schools represents stratified convenience sampling, given the size and the ICT Readiness Index, i.e. the ratios of certain categories of size (small, optimal and big school) and the Index (1, 2 and 3) which are found in all 151 schools are retained in the sample of the selected 40 schools, as can be seen from Table 7. We believe that the ICT Readiness Index is currently the best available measure that indicates the digital maturity of the schools. By keeping the original ratio of categories, in this variable on the sample of 40 schools, we have tried to provide sufficient variability in the digital maturity of schools which, in statistical terms, provides the clue on a significant effect if it exists in the population. Table 9 (attached) contains a list of 40 schools that were selected based on criteria described above.

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[4] The ICT Readiness Index refers to an estimation of the technical readiness of schools for the application of ICT, and teaching staff's level of education for the introduction of ICT in teaching and learning. The estimation will provide headmasters (CARNet: Necessary conditions and criteria for the selection of schools which will participate in the e-Schools pilot project. Public call for schools to participate in the e-Schools pilot project: Establishing the development of digitally mature school).

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Table 7. *The Frequencies and Percentages of Individual Categories of Variables that were Used as Criteria for the Sampling of 40 Schools in Populations and Samples of Elementary (ES) and High (HS) Schools*

		Population (101 ES)		Sample (28 ES)		Population (50 HS)		Sample (12 HS)	
		f	*%*	*f*	*%*	*f*	*%*	*f*	*%*
The Size of the School	Optimal	29	41	11	39	15	42	4	33
	Big	41	59	17	61	21	58	8	67
ICT Readiness Index	1	37	37	9	32	17	34	4	33
	2	32	32	9	32	13	26	2	17
	3	31	31	10	36	20	40	6	50

5.6.1. Educational Staff

Educational staff includes teachers and professional staff of a school. Professional staff at a school can be pedagogues, psychologists, special education teachers, and librarians. Since only a small number of professional staff is employed in schools, in the on-line part of the examination (initial and final examination) all professional staff from each of the 151 schools involved in the project will participate.

As already pointed out, the effects of the e-Schools project should be checked primarily on teachers of science subjects. Therefore, the sample will include all teachers of science subjects who will in academic year 2017/18 teach 7th and 8th grades of elementary schools or 1st and 2nd grade of high schools, and the remaining 30% will comprise of teachers (randomly selected) from each school. School coordinators will submit to the research team a number of teachers who work in their school and the number of teachers of science subjects will be emphasized. Of the remaining number of teachers (not taking into account teachers of art subjects (music, visual art, technical education, physical education), teachers of elective courses, and teachers who do not teach 7th, 8th, 1st, or 2nd grade) teachers who will enter the sample will be determined by the random numbers. The school coordinators will to the random numbers (which will be given by the research team) allot teachers (from the alphabetical list of teachers) and will return the list to the research team. The research team

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will integrate the lists of teachers from all schools and those teachers will participate in the initial and final on-line testing.

In addition to participating in an on-line questionnaire survey, a number of teachers of science subjects will participate in additional testing of digital competences through performance tasks, as well as in evaluation of the effects of learning scenarios application on cognitive learning outcomes. This will primarily be teachers who will participate in the evaluation of the selected trainings. Therefore, while organising the trainings, it is necessary to take into account that primarily teachers of science subjects should be involved and participate in trainings of digital competences. A detailed explanation was previously written, in part *Specific measurement procedures*.

5.6.2. Headmasters and Administrative Staff

In the initial and final on-line testing all headmasters of all schools involved will participate. From the total of 151 schools involved in the e-Schools project 50% of the administrative staff will be tested. Since 10 schools plan to develop and introduce specific business processes, from these schools (if such processes should develop and be put into practice during this study, and if the administrative staff should be specially trained for that) all administrative staff will participate in testing.

5.6.3. Students

In the initial and final on-line testing a representative sample of students, determined by random selection, will participate. From each of the 151 schools included in the e-Schools, 10% of the students will participate in the on-line testing, and they will be determined through a random selection. From each school participating in the study, list of students per class (7th and 8th for the elementary, or 1st and 2nd for high schools) will be asked, and from each class 10% of the students who will participate in the questionnaire study will be randomly chosen. This means that each school coordinator will give the research team a number of students in each grade (7th, 8th, or 1st and 2nd grade). The research team will, based on computer programs

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(random number generator), determine which students will (numbered in alphabetical order) participate in an on-line survey. After generating random numbers, each coordinator will get a table with numbers (for each class of his school which is participating in the study), where they will enter information on the student next to the number. The research team will collect these information from each Coordinator and integrate them into the overall list of students participating in the initial and final on-line questionnaire survey. Coordinators will be asked to indicate whether in some of the classes that are being tested in their school a student with disabilities is integrated, so they can be included in the sample additionally. Students with disabilities who are educated under the regular program with individualised planning will be included. All these students will fill on-line questionnaire measures at the beginning and end of the study. Besides them, all students of those classes for which the effects of application of learning scenarios on the specific cognitive learning outcomes will be evaluated will participate in the initial and final on-line questionnaire study, as was previously described.

In addition to participating in the on-line part of the research, part of the students (selection of these classes is described in the section *Specific measurement procedures*) will participate in the additional testing of the specific cognitive outcomes and tasks for the assessment of digital competences, all related to the application of learning scenarios. Students and all the classes that will participate in the examination of the effects of the application of learning scenarios, test of digital competences through performance tasks, and test of the specific cognitive outcomes will be selected from the 40 schools, as was already discussed.

5.6.4. Students and Teachers at the Center for Education Krapinske Toplice

Center for Education Krapinske Toplice, educational institution for the upbringing, education and care for the children with disabilities, is included in the e-Schools project. Due to special nature of the school, students and employees of the school are treated as a separate sample. In the initial and final on-line questionnaire survey all educational and administrative staff of this school (including the headmaster) will participate. Also, teachers and professional associates will participate in the qualitative part of the study, as was previously described (in

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the part of *Research at the Center for Education Krapinske Toplice*). Students will participate in the study according to their means, as agreed with the professional staff of the Centre. Data on students, in addition to teachers, can give student's parents if necessary.

Graphic representation of the measuring procedures and corresponding samples is shown in Figure 8.

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Figure 8. *Representation of Measurement Procedures and Corresponding Sample of Respondents*

Initial and final on-line questionnaire

Evaluation through specific measuring procedures

Representative sample from all 151 schools

Teachers and classes from the 40 selected schools

Examination at the Center for Education Krapinske Toplice

1. all teachers of science subjects and the remaining 30% of teachers;
2. all professional staff;
3. 50% of administrative staff;
4. all administrative staff from the 10 schools in which it is planned to develop and introduce specific business processes;
5. all headmasters;
6. 10% of the students from the 7th and 8th grade, or 1st and 2nd grade;
7. all students from those classes which will participate in the study of the effects of the learning scenarios on cognitive

Evaluation of the effects of the trainings

- 3 selected trainings
- 2 to 3 groups of participants
- expected 120 teachers

Evaluation of digital competences of teachers through performance tasks

- specific qualitative methods and techniques
- teachers, professional staff, and, in accordance with the need and possibilities, students and parents

Evaluation of the effects of the learning scenarios on cognitive learning outcomes

- 16 teachers (4 subjects x 4 class) which will implement the learning scenario during lesson presentation in two experimental (application of learning scenario) and 2 control (without the use of learning scenarios) classes

- part of the number of teachers who participated in the training will apply learning scenario in one (experimental) class

- 32 classes in which the learning scenario will be applied
- 32 classes in which the same lesson will be presented without the use of learning scenarios

Evaluation of the effects of the cognitive learning outcomes in students

Evaluation of digital competences of students through performance tasks

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5.7. Planned Statistical Analyses

Analysis of the data will depend on the specific research problem, and it will be done in the statistical program IBM SPSS v20.

Psychometric properties relating to their validity and reliability will first be checked in all applied questionnaires. It will primarily be done using the exploratory factor analysis, with proper rotation and checking of the content validity parameters and calculating the internal consistency reliability coefficients.

After the validity and reliability of measuring instruments is provided, the analysis of the data through the appropriate statistical methods will begin.

The connection of certain sub-elements of the project and the constructs defined by the general objectives will be checked by calculating the Pearson's correlation coefficient. The differences in the results of the respondents (students, educational and administrative staff) in the examined variables will be checked by the t-test and analysis of variance (ANOVA). Since the research will be carried out in two measurement points (the initial and the final testing), repeated measures ANOVA will be used for certain comparisons. The contribution of some of the variables to the explanation of the main research constructs will be check by the hierarchical regression analysis.

Data from the qualitative research, which will be conducted in the Center for Education Krapinske Toplice, will be handled with adequate methodology and shown in relation to the main objective of this part of the research, which in addition to testing the main research constructs include the testing of the students' with disabilities needs for the specialized ICT equipment. As already mentioned in the previous article, since this part of the research involves smaller and purposeful, information-rich sample, focus groups and interviews will be recorded and then transcribed, and in their analysis method of constant comparison will be used, if necessary, with software support (12 MAXQDA). Data collected by different methods/techniques will enable development of case studies of the Center for Education

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Krapinske Toplice. A detailed description of the methods and procedures to be used in this part of the research is presented in the chapter *Research at the Center for Education Krapinske Toplice.*

Interpretation of the results of research will be done in accordance with the highest standards of scientific research, taking into account all the constraints and possible uncontrollable sources of error.

The research results will provide a response to specific questions, defined in sub-goals within the general objectives. The conclusions in relation to the general goals of the research will be brought based on these data. Research findings, together with the results of similar conducted research which are described in the scientific literature, will serve as a basis for the recommendations and further guidelines for planning the continuation of the pilot project (e-Schools 2015 - 2018) through the main project (e-Schools 2018 to 2023), which will continue the introduction of digital technology in elementary and high school education.

5.8. Research Time Frame Plan

The planned scientific research is very extensive, it includes a large number of test constructs with control of effects of a large number of sub-elements of research. Also, it requires measurement in two points of time, in order to compare the findings in the initial (prior to the introduction of certain sub-elements of the project) and the final measurement (after the implementation of the sub-elements of the project). It covers a number of subjects of different groups (students, teachers, professional and administrative staff of schools, headmasters and students (and possibly their parents) and teachers of the Center for Education Krapinske Toplice) and various measuring instruments (questionnaire measures, performance tasks, methods and techniques of qualitative research). It also assumes the close collaboration of the research team and other participants (e.g. education organizers). For the successful implementation of this extensive research it is crucial to determine the schedule, i.e. the

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application and implementation of each phase. Therefore, during the planning of the research it was divided into several stages.

5.8.1. (I) The Initial Phase

The initial phase of the research relates to the preparation of the plan and methodology of the research, and consists of:

- Researching the literature, problem and hypothesis definition,
- Defining the sample of respondents (students, teachers, professional and administrative staff, headmasters, teachers and students of the Center for Education Krapinske Toplice)
- Contacting and preparing the schools, electing the coordinators in schools, workshops for coordinators,
- Preparation of measurement instruments (for the main research constructs and sub-elements of the project) and the specific measuring procedures,
- Defining the procedures for data collection,
- Obtaining approval for the research by the Ethics Committee for the Scientific Research, Faculty of Humanities and Social Sciences, University of Rijeka,
- Drawing up a plan of the work and coordination of associates.

Foreseen duration of this phase is from **September to the end of November 2016**.

5.8.2. (II) Conducting the Scientific Research

Conducting the scientific research includes data collection, analysis, and drawing conclusions and recommendations. Data collection will begin in **December 2016** and will end **in late July 2017**.

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5.8.2.1. Planned On-line Assessment through Questionnaires

a. Initial Assessment

Initial on-line questionnaire testing of teachers is planned for December 2016 and January 2017, as well as testing of the administrative and professional staff, and school headmasters. During December 2016 and January 2017, the parental consent for their children's participation in the study will be collected. These children will fill out the initial on-line questionnaire in January and February 2017, depending on the pace of collecting parental consent.

b. Final assessment

Final data collection from students, teachers, professional and administrative staff, and the headmasters through the on-line questionnaire measures is planned for May and June 2017. Data from the persons responsible for the project will be collected continuously throughout the academic year 2016/2017.

5.8.2.2. Planned Assessment through Specific Measurement Procedures

The focus groups with teachers of the Center for Education Krapinske Toplice is planned for January 2017, while the students of the school will participate in the research during the January and February 2017. The second focus group is planned for May 2017.
Testing of specific cognitive outcomes related to Digital Educational Content (DEC), applied learning scenarios, and digital competence of students is planned for the period from February to May 2017.

The initial and final testing of students' outcomes associated with the use of learning scenarios will be adapted to the pace of their development and implementation.

Data collection on the digital competences of teachers (related to specific trainings) and administrative staff will be implemented from February to the end of May 2017.

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5.8.2.3. Data Collection from other Sources

Merging the data from "e-Matica" will take place during June and July 2017, which means that the complete database will be ready in July 2017. The information from database "e-Matica" will primarily be used for merging the data gathered using different methods (e.g., OIB) in order to protect the privacy of study participants. Also, the will be used in the sampling process.

Initial data on self-evaluation and external evaluation of digital maturity of schools will be collected during December 2016. Data on final measuring (self-evaluation and external evaluation of the digital maturity of all the 151 schools) should be made available to the research team by July 2017, to be added to all the other data in the final database.

5.8.2.4. Analysis of the Collected Data

Psychometric analysis of measuring instruments will be implemented from December 2016 to July 2017, depending on the pace of data collection.

By October 2017, statistical analysis of all collected data (initial and final measuring, on-line questionnaire measures, measuring through specific procedures) from students, teachers, professional and administrative staff, and headmasters will be carried out.

5.8.3. (III) Final Phase

The final phase involves making of the final report, in which implemented activities, the period of specific activities and deadlines, human resources, and review of the conclusions of the study and recommendations will be presented concisely. A set of conclusions and recommendations based on the entire study for each of the goals with the detailed review of the effect of certain elements of the project will be developed by the end of January 2018.

Detailed view of the schedule of conducting activities within the tasks planned for the scientific research is graphically displayed in Gantt chart (Table 8).

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Table 8. *Detailed Display of the Implementation Activities Schedule*

Steps and Activities	2016				2017												2018	
	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1. INITIAL PHASE																		
1.1. Preparation of the Plan and Methodology of the Research	■	■	■															
1.1.1. Researching the literature, problem and hypothesis definition	▨	▨	▨															
1.1.2. Defining the	▨	▨	▨															
1.1.3. Preparation of measurement instruments	▨	▨	▨															
1.1.4. Defining the procedures for data collection	▨	▨	▨															
1.1.5. Obtaining approval for the research	▨	▨	▨															
1.1.6. Drawing up a plan of the work and coordination of associates	▨	▨	▨															
1.1.7. Drawing up the initial report			▨															
2. CONDUCTING THE SCIENTIFIC RESEARCH																		
2.1. Data Collection					■	■	■	■	■	■	■							
2.1.1. Coordination of associates on the research				▨	▨	▨	▨	▨	▨	▨								
2.1.2. Initial data collection through on-line questionnaire: representative sample of educational staff				▨	▨													

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Steps and Activities	2016				2017												2018	
	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2
2.1.3. Initial data collection through on-line questionnaire: teachers of a Center for Education Krapinske Toplice				▓	▓													
2.1.4. Initial data collection through on-line questionnaire: representative sample of administrative staff				▓	▓													
2.1.5. Initial data collection through on-line questionnaire: headmasters of all 151 schools				▓	▓													
2.1.6. Collection of parental informed consents				▓	▓													
2.1.7. Initial data collection through on-line questionnaire: representative sample of students, including students with disabilities					▓	▓												
2.1.8. Initial data collection through on-line questionnaire: the whole classes (related to examination of the effects of the learning scenarios on cognitive outcomes)					▓	▓												
2.1.9. Qualitative techniques and methods (1st focus group)					▓													

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Steps and Activities	2016				2017												2018	
	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2
2.1.10. Application of qualitative techniques and methods in Center for Education (data collection of students)					▓	▓	▓	▓										
2.1.11. Evaluation of the effects of learning scenarios on cognitive outcomes (64 classes)					▓	▓	▓	▓	▓									
2.1.12. Assessment of digital competences of the students through performance tasks (32 classes)					▓	▓	▓	▓	▓									
2.1.13. Assessment of the effects of the training (2 groups of participants for the 3 selected trainings)					▓	▓	▓	▓	▓									
2.1.14. Assessment of digital competences of the teachers through performance tasks					▓	▓	▓	▓	▓									
2.1.15. Data collection on digital competences from all administrative staff (10 schools which had new business processes developed)					▓	▓	▓	▓	▓									
2.1.16. Data collection on goals realisation				▓	▓	▓	▓	▓	▓	▓	▓							

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Steps and Activities		2016				2017												2018	
		9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2
2.1.17.	Final data collection on a representative sample of educational staff through the on-line questionnaire																		
2.1.18.	Final data collection from a teacher of Center for Education through the on-line questionnaire																		
2.1.19.	Application of qualitative techniques and methods in Center for Education (2nd focus group)																		
2.1.20.	Final data collection on a representative sample of administrative staff through the on-line questionnaire																		
2.1.21.	Final data collection from all the headmasters through the on-line questionnaire (151 schools)																		
2.1.22.	Final data collection on a representative sample of students, including the students with disabilities, through the on-line questionnaire																		
2.1.23.	Final data collection of whole classes																		

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Steps and Activities	2016				2017												2018	
	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2
2.1.24. Merging the data from "e-Matica"										█	█							
2.1.25. Creating the data base				█	█	█	█	█	█	█	█							
2.2. Analysis of Quantitative and Qualitative Data				█	█	█	█	█	█	█	█	█	█	█	█	█	█	█
2.2.1. Analysis of the reliability and factor validity of the measurement instruments				█	█	█	█	█	█	█	█							
2.2.2. Statistics analysis: descriptive statistics, correlation and regression, t-test and analysis of variance					█	█	█	█	█	█	█	█	█	█				
2.2.3. Report on preliminary analysis of quantitative and qualitative data															█			
2.3. Conclusions and Recommendations															█	█	█	
3. FINAL PHASE																		
3.1. Final report																	█	
4. CONTINUOUS TASKS																		
4.1. Presentation of the results				█	█	█	█	█	█	█	█	█	█	█	█	█	█	█
4.1.1. Presentation of the initial report				█														
4.1.2. Presentation of the progress in the achievement of the results and/or intermediate results				█	█	█	█	█	█	█	█	█	█	█				
4.1.3. Presentation of the final report																		█
4.1.4. Presentation of the conclusions and recommendations																		█

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5.9. Research Risks

The success of extensive research such as this depends on a number of factors, which may be more or less controlled. These factors also represent the main risks or possible obstacles for the successful implementation of the research.

5.9.1. Risks arising from the research time frame plan

One of the biggest risks in conducting this study stems from the fact that the deadline is fixed and defined, and it did not adapt to the beginning of the research, i.e. the date of signing the contract. For this reason, all measurements are planned for the 2016/17 academic year, which leaves very little time between the initial and the final measurement. Due to the short period of time, it is possible that some effects will not be determined, because the time frame is too short for the effects to occur at all. Also, a short period means that some measuring must be done parallelly, which can definitely affect the quality of research.

5.9.2. Risks related to the research participants

Since the study involves underage students of 7th and 8th grades of elementary and 1st and 2nd grades of high schools, it is necessary to obtain a consensual agreement of the parent/guardian for their participation in the survey, which can affect the representativeness of the sample. Students participating in the study were selected according to the case, which means that it is necessary to ensure that they are tested, i.e. that their parents give their consent to participate.

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5.9.3. Risks Relating to the Methodology - Questionnaire and On-line Testing

Research risks also depend on the methodology to be applied. When testing an on-line questionnaire, it is important to ensure good cooperation and communication with the coordinators of schools, in order to have data collection carried out in due time. Any deviation of deadlines for data collection affects the next stage of the project.

For the successful implementation of the on-line part of the research, it is important to ensure adequate infrastructure (fast Internet connection, access to on-line questionnaires), which supports the establishment of large on-line databases. The database must be able to safely store large amounts of data, to which the researchers should have easy access. Any ineffectiveness of the IT system can adversely affect the quality of the research.

Since the testing is planned to be conducted within an academic year, due to the relatively short time between the initial and the final measuring, there is a possibility that all effects of the project on major research constructs could not be detected.

5.9.4. Risks Relating to the Methodology - Specific Measurement Procedures

In a part of the research involving performance tasks (specific cognitive learning outcomes, tasks for testing digital competences), particularly concerning the application of digital educational content and learning scenarios, it is essential to ensure close cooperation between members of the research team and other associates of the Project, particularly those dealing with the development DEC and learning scenarios. Researchers must have insight into the plan of the development and the application of DEC and learning scenarios in order to be able to plan research activities (primarily initial measuring, before applying the learning scenario). For the successful implementation of this part of the research, it is necessary to ensure the

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following: 1. Researchers must know in advance which of learning scenario is being developed (for which subject, grade, and teaching unit), 2. the schedule of application of learning scenarios (including which schools/grades/classes), 3. what are the expected learning outcomes for each developed learning scenario. The availability of all the relevant information is extremely important for the quality of the research of the effect of the learning scenarios on key research constructs. The research team expects that, prior to the application of certain learning scenarios, they will be consulted and that they will closely collaborate with the partners on the project, which are responsible for their development.

Since the effects of the DEC and learning scenarios application must be tested for all four science subjects, for all 4 classes, it is necessary that all of them are developed and implemented in the planned time, defined by the research schedule. If DEC or learning scenarios should not be developed and implemented in a specific time, as was planned, their effects on the main research constructs will not be able to examine.

A particular problem in this part of the research, which includes testing the effects of learning scenario on cognitive learning outcomes, presents motivation of the teachers who will participate in this part of the research. In addition to their participation in the initial and final on-line questionnaire study, these teachers will be involved in putting together the specific learning scenarios for a particular teaching unit, application of learning scenarios in two classes, and presenting the same teaching unit without the use of learning scenarios in the other two classes. It is important to ensure that teachers who will participate in this part of the research are extremely motivated and willing to cooperate and work together. And their students (all classes, not a specific sample of students from the class section) will participate in the testing of digital competences through the performance tasks, and in the study of achievement of cognitive learning outcomes, as well as in the initial and the final on-line questionnaire survey. In order to have this part of the research planned in great detail in advance and successfully implemented, it is necessary to have a close cooperation of the research team, coordinators of schools and teachers.

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The research team also must be informed in advance on plan of trainings of educational and administrative staff (when are individual trainings planned to be introduced, content and the type of training, manner of implementation of the training, whether the training has formative evaluation of acquired knowledge) in order to adequately verify the effects of the training on major research constructs.

The research team must have the information in advance on which 10 schools new business processes will be introduced, to be able to plan the sample of the administrative staff who will participate in the study.

5.9.5. Risks Relating to the Methodology - Data from other Sources and Cooperation with Partners

Researchers must obtain timely and relevant information from "e-Matica". Also, they should have access to all information related to the initial and final measuring of digital maturity of schools (self-evaluation and the external evaluation). Data on final measuring of digital maturity should be available at the same time as the final measuring questionnaire survey, in order to analyze their effects. If these data are not available, and self-evaluation and external evaluation of digital maturity should not be carried out, it will not be possible to resolve general goal No. 5, i.e. it will not be possible to examine the effect of the implementation of the pilot project on the digital maturity of the schools in relation to the Framework for the Digital Maturity of Schools. The research team also needs to have access to the comprehensive Framework for the Digital Maturity of Schools, since it is necessary to determine the effect of the implementation of the pilot project on the results of the school with respect to the Framework.

Successful realization of the project's goals also depends on other partners of the project (primarily for the development of the Framework for the Digital Maturity of Schools, the development of digital educational content, and the appropriate training of teachers and administrative staff).

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From a review of these risks, it is obvious that for the successful implementation of research it is necessary to have close cooperation between the members of the research team and the client of the project, as well as all other contributors on the project. Through good cooperation during the implementation of the research most of these risks could be mitigated and prevented.

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APPENDIX

Table 9. *Name, Location, Size and Readiness for the Introduction of ICT of the Selected 40 Schools*

School's Name	The size of the School	ICT Readiness Index	Location
Dragutin Tadijanović Elementary School	optimal	3	Vukovar
Gustav Krklec Maruševec Elementary School	optimal	2	Maruševec
5th Elementary School of Varaždin	optimal	3	Varaždin
Franjo Krežma Elementary School	optimal	3	Osijek
Vežica Elementary School	optimal	3	Rijeka
Ksaver Šandor Gjalski Elementary School	optimal	1	Zagreb
Zapruđe Elementary School	optimal	2	Zagreb
Viktor Car Emin Elementary School	optimal	2	Lovran
Cvjetno naselje Elementary School	optimal	2	Zagreb
Otok Elementary School	optimal	2	Zagreb
Lovro pl. Matačić Elementary School	optimal	3	Zagreb
Vladimir Nazor Elementary School	big	3	Čepin
Ivan Lovrić Elementary School	big	1	Sinj
Mladost Elementary School	big	1	Osijek
Tenja Elementary School	big	1	Tenja
Manuš Elementary School	big	2	Split
Pehlin Elementary School	big	2	Rijeka
2nd Elementary School of Varaždin	big	3	Varaždin
Gornja Vežica Elementary School	big	3	Rijeka
Grigor Vitez Elementary School	big	1	Zagreb
Vladimir Nazor Elementary School	big	1	Zagreb
Fran Galović Elementary School	big	1	Zagreb
Silvijo Strahimir Kranjčević Elementary School	big	1	Zagreb
Antun Mihanović Elementary School	big	1	Zagreb
Bukovac Elementary School	big	2	Zagreb
Antun Gustav Matoš Elementary School	big	2	Zagreb
Izidor Kršnjavi Elementary School	big	3	Zagreb
Ivo Andrić Elementary School	big	3	Zagreb
Medical School Varaždin	optimal	3	Varaždin
First Croatian Gymnasium in Rijeka	optimal	1	Rijeka
12th Gymnasium	optimal	2	Zagreb
Geodetic Technical School	optimal	3	Zagreb
Technical High School and Natural Science Gymnasium Ruđer Bošković	big	1	Osijek
First Gymnasium Varaždin	big	2	Varaždin
Engineering and Traffic School	big	3	Varaždin

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School's Name	The size of the School	ICT Readiness Index	Location
Craft Technical School	big	3	Split
Nursing School	big	3	Split
School of Natural Sciences Vladimir Prelog	big	1	Zagreb
2nd Gymnasium	big	1	Zagreb
15th Gymnasium	big	3	Zagreb

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