

THE CONNECTION BETWEEN STUDENTS' COGNITIVE DEVELOPMENT AND THEIR USAGE OF ICT IN THE EDUCATIONAL PROCESS

Angela Ikonomoska¹

Institute of Pedagogy

Faculty of Philosophy - Skopje

Ss. Cyril and Methodius University in Skopje

Abstract

Mass digitization during the pandemic caused by the Coronavirus has made today's normal life almost unimaginable without the use of technology. According to the needs of the digital age, the use of information and communication technology (ICT) in schools has increased significantly. ICT is an important component of the educational process that has a considerable impact on students' cognitive development. There is no definitive response to the questions of where ICT should be used in the pedagogical process and how it affects students' cognitive development abilities. From here, the aim of our scientific paper is to provide a detailed consideration of the relationship between the use of ICT and the cognitive development of students. A theoretical framework is presented, and relevant research findings and challenges concerning students' ICT competencies and their impact on cognitive development are analyzed. Looking at comparative knowledge, we saw the constructive side of technology that affects cognitive development and learning. All this highlights the vital importance of students' ICT competencies, which influence the development of cognitive abilities (perception, attention, memory, thinking, imagination). According to the nature of the researched problem, which is constantly evaluated, it is necessary to highlight the need for appropriate and targeted use of the resources offered by technology, emphasizing the proper development and upgrading of the ICT competencies of students and teachers, the development of new modern strategies for self-regulation in the digital learning environment, as well as the acquisition of positive habits for continuous improvement of one's personality.

Keywords: *cognitive development, ICT, educational process, students.*

¹ angela.ikonomoska@fzf.ukim.edu.mk

Led by the fact that technique and technology are taking an increasingly important place in the functioning of society, we see that the application of information and communication technology (ICT) in teaching and learning is gradually increasing. We are continually witnessing suggestions and progressive realizations for societal digitization, with education serving as the most significant sphere. In other words, the educational system is constantly subjected to a succession of adjustments, innovations, and reforms that are driven by societal needs and technological advancements. The new philosophy of living and working has been integrated into society's essential functions, requiring future generations to exhibit greater democracy, flexibility, creativity, originality, and endurance.

ICT literacy, or the “competency of the 21st century,” is a term that is frequently used in educational discussions. To satisfy the fundamental requirements of educational practice, antiquated teaching and evaluation methods must be refined and modernized. Above all, knowledge should enhance all competencies, including media literacy and information skills, cooperation and communication skills, creativity, critical thinking, and problem-solving abilities, as well as the ability to use them effectively and productively in one's own and society's development. Thus, 21st-century competencies and pedagogy can play an integral role in structuring a transdisciplinary approach to the school curriculum (Voogt et al., 2013). In this context, it is important to underline the necessity of making ICT a priority, which involves constructing schools from the ground up to allow for the effective use of all the potential that ICT offers in education.

New and advanced technologies like virtual reality, augmented reality, artificial intelligence, and machine learning are changing how we use and interact with technology. These technologies can help us learn and develop our thinking abilities in exciting ways (Getuli et al., 2020). They offer interactive and immersive experiences that can improve our attention, memory, and problem-solving skills. In other words, they make learning more fun and effective (Ilić et al., 2021). The convergence of the two phenomena - new technologies and digital social support - has caused interest in understanding how they interact and influence cognitive development among students (Bygstad et al., 2022). Educating today's students will prepare a generation that is predicted to innovate to raise living standards.

Theoretical background

Three main theories of learning that are most frequently applied in the design of learning environments are behaviorism (observable change in behavior), constructivism (construction of knowledge from experience), and cognitivism

(change in internal schemata). Due to the nature of the problem that we are dealing with in this scientific paper, we will further analyze the theoretical foundations of cognitivism and constructivism in more detail.

The theory of cognitivism is concerned with mental processes. The cognitivist model holds that an individual's mental processes dictate how they learn. The cognitive approach views the learner as a thinking being and an active processor of information (Suharno, 2010). We can see that cognitivism is based on the idea that when students learn something new, their past knowledge constantly connects to the new information. According to the cognitive hypothesis, the human mind operates similarly to a computer or information processor. As a result, the cognitivist perspective views learning as an interior mental process that goes beyond outwardly visible behavior.

On the other hand, constructivism is a theory of learning or meaning-making that enables people to create new understanding based on an interplay between what they already know and believe and the concepts and knowledge with which they interact (Ertmer & Newby, 2013; Resnick & Glaser, 2016). Constructivism established itself as an intellectual movement for the study of the mind and its many processes as early as the late 1950s. In essence, The Cognitive Developmental Theory of Learning is thought to include constructivism. Constructivism is predicated on the notion that students build new knowledge from what they already know and have experienced. Constructivism, in this context, focuses on the cognitive development of students and is characterized as a theory of how students learn by construction, that is, through the ongoing co-construction of their knowledge through interaction with the environment, essentially as an internal process based on students' mental capacities. This suggests that education is an active process that involves direct interaction and investigation of the environment (Damovska, 2023; Ormrod, 2019). As we can see in brief, the main difference between constructivism and cognitivism is that constructivism explains how learners use prior knowledge to grasp new knowledge, whereas cognitivism describes how learning occurs through the internal processing of information.

Going back to the beginnings of the development of theories of cognitive development, the representatives of the two dominant psychological schools cannot go unnoticed - Piaget's (cognitive-developmental constructivism - how children shape the world) and Vygotsky's (socio-cultural constructivism - how the world is shaped by children). Exposing various theories of children's cognitive development and learning has had a huge impact on the contemporary development of cognitive development, placing the student at the center of the learning process. They pointed out how children's development can be stimulated in the direction of acceleration, or its acceleration, or in the direction of amplifica-

tion, that is, enrichment of psychic development with maximum achievement of the dominant features of cognitive development in a certain developmental phase. Learning is considered constructed, active, reflective, collaborative, inquiry-based, and developed in so-called constructivist classrooms (Damovska, 2019; Prakash Chand, 2023).

Since the point of our further text is not to analyze constructivism in detail from a radical and social aspect but to perceive it as a basis for the development of other domains of development (socio-emotional and physical health), in the following, we will briefly highlight only the segments in which both theories agree:

- children are active creators of their knowledge;
- the internal thought processes of children are recognized, but so are the social influences on the development of these thought processes;
- value the role of the environment in the development of the thinking process in children;
- they observe knowledge as a subjective construction of the reality in which the child exists;
- Value children's internal motivation for learning and development and their basic motivation for exploring and manipulating objects as a way of understanding the world around them (Damovska, 2023).

The way we live, communicate, and learn has changed dramatically in the last two decades due to technology. With the development of modern technologies, teachers and students can now access a world outside of the classroom due to their simplicity, power, and diversity of information conveyance. Interactivity, flexibility, and convenience have become the order of the day in an ICT-supported environment. Technology provides chances for learning by allowing students to access, expand, modify, and exchange concepts and knowledge in a variety of multimodal communication formats. Along with fostering learner-centered and collaborative learning concepts and improving critical, creative, and problem-solving thinking abilities, it aids in the sharing of learning materials and places (Majumdar, 2006). It is not by chance that we attached the segments in which the theories of Piaget and Vygotsky are aligned because we can also find them in the background of the modern way of learning students in the presence of modern technology. Looking at the core of traditional education, the goal is for students to acquire a certain amount of knowledge, skills, and abilities. But at present, the main task of the school is not so much to enrich schoolchildren

with knowledge as to teach them to independently acquire knowledge and teach them to learn. The ability to learn is especially important in the so-called modern world because changes happen quite quickly in all areas of professional activity. Students are allowed to speed up the process of independent learning and in-depth research on the topics that arouse their interest, thereby improving their digital literacy skills from an early age.

According to the changes and innovations of the new social life, the new generations must possess the so-called 21st-century skills (Figure 1).

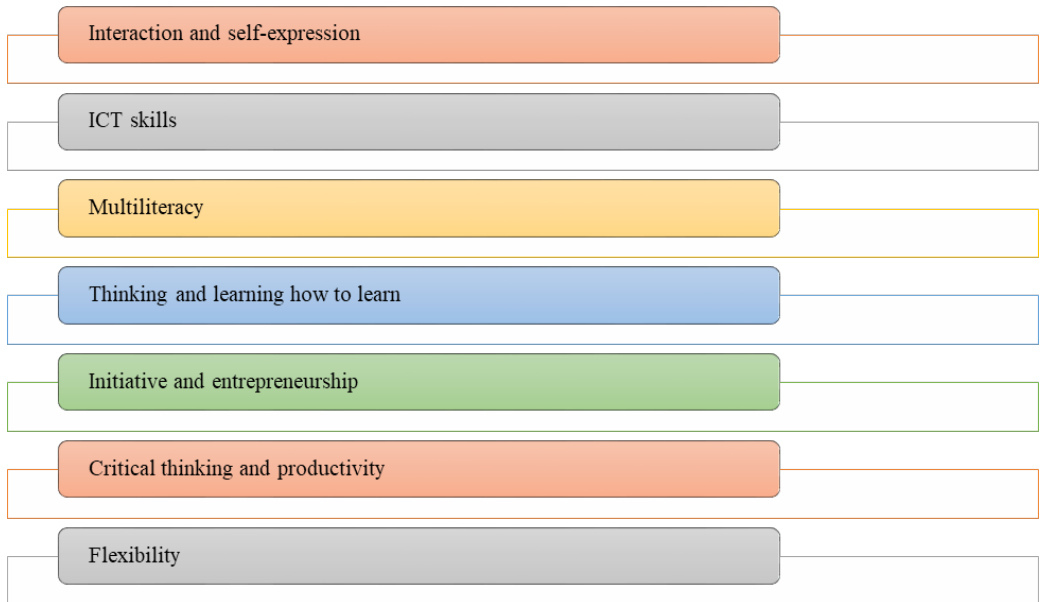


Figure 1. *21st-century skills*

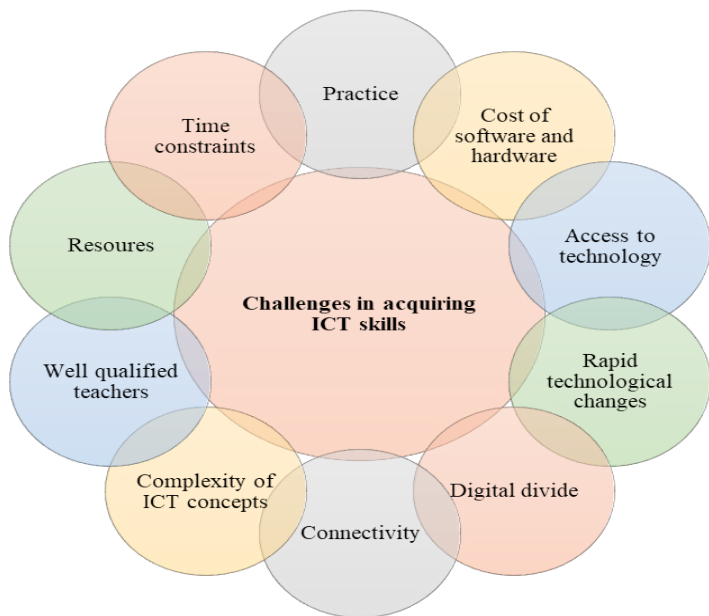
In any case, it is impossible to ignore or fail to bring up the relevance and applicability of the two aforementioned theories. The underlying social settings should be reflected in learning demands and the theories that explain learning principles and processes. As a result of these visible changes, George Siemens and Stephen Downes in 2005 developed a theory for the digital age, called connectivism - denouncing boundaries of behaviorism, cognitivism, and constructivism. Their proposed learning theory has issued a debate over whether it is a learning theory or instructional theory or merely a pedagogical view (Duke et al., 2013). According to Siemens (2005), connectivism is the integration of principles explored by chaos, network, complexity, and self-organization theories. In its most basic form, connectivism is networked social learning, and Downes described it as: "At its heart, connectivism is the thesis that knowledge is distributed across a network of connections and, therefore, that learning consists of the ability to con-

struct and traverse those networks.“ (Downes, 2007). Connectivism is an approach to learning that builds upon constructivism by placing the students at the center and having them connect and construct new information within an environment that includes social media and other external networks. According to connectivism, learning is now a collaborative process of scholarship that transacts through time and space rather than being limited to cognitive or individualistic activities. This means that learning can occur anywhere, at any time, and without regard to distance or location (Hendricks, 2019).

The need for acquiring students’ ICT skills

ICT skills cover the main elements of students’ informational culture and are based on their professional self-determination, taking into account individual possibilities. They are associated with the qualities of a technically and technologically educated person, ready for life and active work in the conditions of a modern high-tech information society. Stated differently, what we are discussing is students’ digital and media literacy, which manifests in their proficiency with digital media and ICT tools. The widespread usage of social media and social networking sites motivates students to become proficient in a variety of cutting-edge communication technologies and to use online communities as learning resources (Dzhurylo & Shparyk, 2019). The process of acquiring ICT skills is spontaneous but intertwined with challenges that can affect their practical application (Figure 2).

Figure 2. *Challenges in acquiring ICT skills*



Students' interests as active subjects should be reflected in their education. It is crucial to highlight that one of the fundamental responsibilities of the educational system is to teach students how to use contemporary information and communication technology appropriately. As one of the eight essential competencies outlined in the European Qualifications Framework for Lifelong Learning, digital competence is a universal benefit in the modern, computerized world since it offers societal prosperity and high-quality educational opportunities. Analyzing the European Commission's framework of separate competencies and the key competencies for lifelong learning from the European reference framework, we can see that the importance of digital literacy is also emphasized in the national elementary education standards. The ICT competencies that students must acquire during their elementary education include using technology in an appropriate, moral, and safe manner; using it to solve problems and come up with new ideas; collaborating and communicating both within and outside of the classroom; creating digital material, and other related skills (National standards for student achievement at the end of primary education, 2021).

The impact of ICT on students' cognitive development

The usage of technology in education is founded on a combination of experience knowledge gained from practice and theoretical information from a variety of disciplines, including computer science, pedagogy, psychology, sociology, and philosophy. The major objectives of integrating ICT into education are to improve teaching performance, speed up the learning process, and present the content in an engaging visual manner. Other goals include encouraging student participation and motivation throughout the lesson and utilizing contemporary teaching resources and pedagogical communication models (Aleksoski, 2003; Courville, 2011).

Looking at the core of traditional education, the goal is for students to acquire a certain amount of knowledge, skills, and abilities. But at present, the main task of the school is not so much to enrich schoolchildren with knowledge as to teach them to independently acquire knowledge and learn. In the so-called modern world, where changes occur swiftly in all spheres of professional activity, learning agility is particularly crucial. From an early age, students can enhance their digital literacy by expediting their autonomous learning process and conducting in-depth research on topics that spark their interest. Accordingly, each needs to upgrade and improve his qualifications. That is, we can say that modern life requires a person to have well-developed cognitive abilities (perception, attention, memory, thinking, and imagination) (Rakhimovich & Ibrokhimovich, 2021).

Compared to previous generations, most children today are born with technology. Many of them are familiar with basic managerial tasks and had experience using a computer or mobile phone before beginning to use one for educational reasons in elementary school. We corroborate this with statistics indicating that children in European countries frequently utilize more technological devices (Mascheroni & Cuman, 2014).

In itself, the digital technological expansion as part of everyday life raises several questions related to everyday interaction with digital devices. Since digital experiences are a vital component of seeing, investigating, and contemplating the outside world, they are intrinsically linked to the cognitive growth of every person. Cognitive development is actually supported and encouraged by learning about the digital world and progressively developing the skills necessary to operate the newest technology (Proekt et al., 2020).

Many studies begin by examining how preschool-aged children use technology to play, in keeping with the perspective that holds that a person's personal development is intimately tied to technology. Constructive use of technical devices can lead to healthier and more efficient minds. This is exactly what Pertiwi and Prakosa (2021) concluded in their research, in which the obtained results show that both children who spend less time in front of a technical device and children who spend more time in the presence of a technical device have well-developed cognitive abilities that they show them by solving given problem situations. The difference between the two groups of children is in the way they play. The group that uses fewer technical devices plays games such as Lego blocks, models with colored sand or plasticine, feeding animals, etc. In the other group, which uses technology more frequently, it is demonstrated that children have very little interest in reading aloud from books or engaging in other traditional activities since they can use technology to expand their imaginations. The gameplay in the virtual world is compared to real-world toys. The digital and the non-digital are intertwined, so it is more appropriate to consider the game holistically. It is recognized that digital play develops a range of abilities, including subject knowledge and understanding, digital skills, and skills related to social, emotional, cognitive, and creative development (Scott, 2021).

Children are gradually moving into the so-called school age, where the use of technology is increasing because it is a part of every student's daily life in school and at home. According to Sen (2010), primary education is the foundation for a child's learning, on which every other level of learning depends. Researchers believe that achieving these functions requires language development, memory development, concept formation, perception, intelligence, and the use of innovative pedagogies (Obiweluozo, 2016). In the context of this, we can refer to the

key pedagogical reform for effective teaching and learning to achieve literacy, numeracy, and communication - the introduction of information and communication technology (ICT). It has become an indispensable part of the education system. Researchers, academics, and industry professionals have proven that ICT provides opportunities for all educational participants to learn and excel. Across the world, it has been accepted by educational planners that increased exposure of students to educational ICT through curriculum integration has had a significant and highly productive impact on their achievement (improved their knowledge, comprehension, practical skills, presentation skills, and innovative capabilities to a great extent) (Tariq Zafar, 2019). The majority of students view technology and its gadgets as essential components of daily life. The rapid transfer of information and the increase in the level of assimilation contribute to the development of processes such as attention, memory, thinking, imagination, speech, sense of color, and participation in intellectual, emotional, and moral development (Kozlovskiy et al., 2021).

The findings of numerous studies indicate that integrating interactive, technology-based learning spaces can enhance students' capacity for higher-order thinking, creativity, decision-making, and problem-solving skills. It has been discovered that students' cognitive engagement, retention of information, and general academic achievement are all positively impacted by the transition from conventional, teacher-centric instruction to more learner-centered approaches supported by ICT (Hu et al., 2018; Ishaq et al., 2020; Nadeem et al., 2018; Saarinen et al., 2021). We supplement this with findings from Anyanwu and Kalu (2021), which demonstrated that students' intellectual capacities are highly influenced by their level of ICT proficiency. This is confirmed because, as they use ICT, there is a high tendency for their intellects to process the information they receive in the act of its usage, thereby enhancing their intellect. This result is in line with the outcomes of Ukwueze and Ajala's (2014) study, which showed that the abundance of contemporary ICT resources raises students' self-efficacy and confidence and promotes effective and efficient learning.

The accompanying research makes it abundantly evident that, to meet the demands of the modern day, technology has an impact on students' growth and learning environments by helping them visualize concepts and future objectives (Kilag et al., 2022). Along with the advantages offered by technology, there is always concern about its negative effects. Issues related to the impact of technology on physical and psychosocial development are present every day. From the perspective of the cognitive domain, the effects on sleep, memory, speaking and reading comprehension, realizing two-way communication, focus, and so on are frequently mentioned (Ricci et al., 2022). This section's further material may be

found in the 2019 OECD (Organisation for Economic Co-operation and Development) Education Working Paper “Impacts of technology use on children: Exploring Literature on the Brain, Cognition, and Well-being” by Francesca Gottschalk.

The World Health Organization (WHO), bearing in mind the negative factors that can affect the overall development of children from excessive exposure to technology, has published a series of recommendations for parents. These guidelines are part of the strategy for raising awareness about sedentary lifestyles and obesity by the Organization of the United Nations (UN) (World Health Organization, 2019). Learning with the help of technical devices must be supervised because it is already clear that basically, everything is only good if used in a positive way or bad if used negatively. It is not possible for students today to stay away from technology, but its presence can still be limited. Encouraging students to use technology in the field of education can bring drastic positive changes.

Conclusion

Based on the knowledge we have obtained through the analysis of the attached literature, it was shown that there is a significant and beneficial relationship between ICT knowledge and the intellectual abilities of students. A “transformative landscape” is revealed by the symbiotic interaction between students’ cognitive development and their use of ICT in education. ICT enriches cognitive processes by encouraging self-directed research, fostering collaborative learning, and piquing interest. It is not just a tool; it is a catalyst. This integration fosters essential abilities like information appraisal, digital literacy, and adaptive problem-solving, in addition to improving technical expertise.

However, pedagogical alignment and strategic execution are key to the effectiveness of ICT in education. Using technology to provide deep learning experiences that go beyond rote memorization and emphasize conceptual comprehension and application, teachers are essential. The close relationship between ICT and cognitive development not only marks a paradigm shift in education but also points to a day when learning will no longer be limited and people will be able to reach their greatest potential.

The nature of the researched problem necessitates highlighting the need for appropriate and targeted use of the resources provided by technology, with a focus on building new, modern strategies for self-regulation in the digital learning environment, acquiring positive habits for ongoing personality improvement, and properly developing and upgrading ICT competencies in both students and teachers.

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ВРСКАТА ПОМЕЃУ КОГНИТИВНИОТ РАЗВОЈ НА УЧЕНИЦИТЕ И НИВНАТА УПОТРЕБА НА ИКТ ВО ВОСПИТНО-ОБРАЗОВНИОТ ПРОЦЕС

Ангела Икономоска

Кратка содржина

Масовната дигитализација за време пандемијата предизвикана од корона вирусот, го доведе денешното нормално живеење скоро незамисливо без користење на технологијата. Согласно потребите на дигиталната ера, значително се зголеми употребата на информациско-комуникациската технологија (ИКТ) во училиштата. ИКТ во воспитно-образовниот процес претставува клучна компонента, која значително влијае врз когнитивниот развој на учениците. Каде да биде сместена ИКТ во педагошкиот процес и како тоа влијае врз когнитивните развојни способности на учениците, се прашања кои немаат дефиниран одговор. Од тука, целта на нашиот научен труд е насочена кон детално разгледување на односот помеѓу употребата на ИКТ и когнитивниот развој на учениците. Претставена е теоретска рамка во која се анализирали релевантни истражувачки наоди и прашања кои се однесуваат на ИКТ компетенциите на учениците и нивното влијание врз когнитивниот развој. Разгледувајќи ги компаративно сознанијата, ја согледаваме конструктивната страна на технологијата која влијае врз когнитивниот развој и учењето. Сето ова го истакнува виталното значење на ИКТ компетенциите на учениците, кои влијаат на развојот на когнитивните способности (перцепција, внимание, меморија, размислување, имажинација). Согласно природата на истражуваната проблематика, која постојано евалуира, неопходно е да ја истекнеме потребата од: соодветно и насочено користење на ресурсите кои ни ги нуди технологијата, ставање акцент на правилното развивање и надоградување на ИКТ компетенциите на учениците и наставниците, развој на нови современи стратегии за саморегулација на дигиталната средина за учење, како и стекнување на позитивни навики за постојано надоградување на сопствената личност.

Клучни зборови: *когнитивен развој, ИКТ, воспитно-образовен процес, ученици.*

