International Journal of Medical Toxicology & Legal Medicine Volume 27, No. 5, 2024
e-ISSN: 0974-4614
p-ISSN: 0972-0448
https://doi.org/10.47059/ijmtlm/V27I5/021

At What Age And How To Learn Computer Science? (based on analysis of foreign sources)

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Received: 15.09.2024 Revised: 18.10.2024 Accepted: 09.11.2024

ABSTRACT
As the digital technologies are becoming a main part of our lives, they are rapidly changing the way of life, living conditions and outlook of humanity to a completely new level. The wide range of digital technologies and their use not only in daily activities, but also in various fields of production, is bringing humanity to the fourth industrial revolution. This industrial revolution, based on the digital revolution, means a transition to fully automated production controlled by intelligent systems.

Keywords: Digital Technologies, Fourth Industrial Revolution, Automation, Intelligent Systems

Summary
The technologies of this revolution are also the basis for the development of the digital economy. A developed digital economy certainly develops the state economy. Therefore, the development of the digital economy on a global scale and the usage of the technologies of the fourth revolution in various fields are getting more attention at the level of state policy. In particular, the leading companies of developed countries are rapidly introducing cyber-physical technologies such as artificial intelligence, big data, automated systems, and Internet of Things into their production processes in order to maintain their top positions in the world arena. These actions are accelerating the digitization process in the world. In addition, due to the Covid-19 pandemic, the majority of human activities are carried out online and the quarantine procedurescreated even more needs and opportunities for digitalization of society's activities and economy.
In the context of the industrial revolution, the problem of training highly qualified specialists who not only use digital technologies, but also produce them, is one of the global problems faced by professionals all over the world.
The development of the digital economy is connected with the development of digital technologies. Digital technologies are based on both hardware and software. It is known that most of the technical devices and software that develop the economy are imported from foreign countries for large investments. This is one of the factors that hinders the development of the digital economy. As one of the ways to eliminate such factors is to establish the production of national products, nowadays, it is crucial to raise and attract new generation of highly qualified specialists to these production processes.
The computer has a great impact on the way of thinking and lifestyle of modern children. Politicians supported by the technology industry are promoting the idea of teaching children how technology works and preparing "digital citizens" for an increasingly IT-based global economy. This is primary education in many countries(ages 7 to 11) has led to the introduction of computer science and an increase in the number of programming tools available to beginners (table 1.):

Table 1. An overview of computer science education in different countries

	Country	Applied science	Status	Primary school	Education after primary education
1	Australia	DigitalTechnologies	Integrated	Mandatory	Mandatory
2	Dania	Informatics	Inside the subject	-	Mandatory
3	Great Britain	Computing	Existing topic hasbeen replaced	Mandatory	Mandatory
4	Estonia	Programming	Integrated	Mandatory	Mandatory

		(Technology & innovation)			
5	Finland	Programming (Digital competence)	Integrated	Mandatory	-
6	Hungary	Information Technology	Inside the subject	-	Mandatory
7	Israel	Computer Science	Inside the subject	-	Mandatory or elective depending on the educational institution
8	Lithuania	Information Technology	Inside the subject	-	Mandatory
9	New Zealand	Programming and Computer Science	Inside the subject	-	Elective
10	Turkey	Computer Science	Inside the subject	-	Mandatory
11	USA	Computer Science	Inside the subject	-	Elective

The 21st century has increased the demand for logo-based environments and programming tools, especially tools such as Alise, developed in 2003 by the Sooper, Dunn, and Pausch team, and Scratch, developed in 2009 by Resnick and others.

Formation and development of algorithmic thinking of the young generation is one of the urgent issues to which the entire world education system is facing, because this skill is very necessary for children to acquire future professions and modern knowledge, in particular, to become programmers. It is reported that by 2030, more than 57 professions will disappear and 186 new professions will appear [1]. What knowledge, skills and abilities should be acquired as a specialist in the digital world? A solution to this problem can be found in Atlas - an almanac of fields and professions with a perspective of the next 15-20 years [2]. According to this data, 60% of new professions of the future will require knowledge and skills related to the creation of software tools.

A.P.Yershov, A.Yu.Pervin, E.A.Zvenigorodsky suppose algorithmic thinking as one of thenecessary forms for programmers and see it along with the development of quantitative and spatial imagination, abstraction, schematization, and other similar mathematical elements. They also claim that it is necessary to form fundamental skills such as algorithmic and logical thinking from the young ages [3, p. 15].

From the literature on psychology, it became known that the basis of logical and algorithmic thinking is figurative thinking. For example, let's pay attention to the model of the structure of figurative thinking by the psychologist I.Ya.Kaplunovich.

According to I.Ya.Kaplunovich, studying different subjects or their images, depending on which of the components of the child's figurative thinking is dominant, determines certain relationships amongchildren [4, p. 49]. This type of thinking skill includes five overlapping components. These are: topological, projective, ordered, metric, compositional (algebraic) components. They begin to form when the child is three years old. E. A.Utyumova also agrees that logical and algorithmic thinking is formed on the basis of these components of figurative thinking[5]:

Table 2. Characteristics of thought forms in each age period

Age period	Types of thinking	Characteristics
3-4	Topological	Determines properties of Objects such as continuous-noncontinuous, relevant-irrelevant, dependent-independent. The ability to move step by step, sequentially, continuously appears.
4-5	Projection	The ability to identify, create, imagine, perform actions, and aim between the viewed objects or its graphic image from different angles, at an arbitrary point.
5-6 (beginning)	Orderly	According to various signs: the ability to determine size, distance, shape, features in space, to classify and establish relationships is formed. The child acts logically, sequentially, consistently. Likes to work with algorithms.
5-6 (end)	Metric	Focuses on quantitative characteristics and changes. For a child, the question "how much" is length, surface area,

		distance, size in numerical expression.
6-7	Compositional (algebraic)	Tends to various combinations, manipulations, identification and reassembly of additional parts, abbreviations, substitutions. A child thinks quickly, acts quickly and makes many mistakes.
6-7	Logical thinking	The child compares and sorts objects, mentally divides them into classes according to their most important features, divides objects into small parts, and then collects them into a whole.
6-7	Algorithmic skill	In order for algorithmic thinking to be formed, algorithmic skill must first be formed in it, and it is formed in the process of working with linear, iterative, and recursive types of algorithms.

The development of computers and mobile devices and their deep penetration into every sphere of human activity, the widespread use of smart devices in everyday life had a unique impact on human thinking. As a result, a person began to think in a new way, and psychologists called this form of thinking as "computational thinking" ("вычислительное мышление") [6; p. 18].
The introduction of the term "computational thinking" into science began in the 50s and 60s of the 20th century based on the concept of algorithmic thinking [7; p. 28].
The definitions given by various scientists to the concept of "computational thinking" are presented in the table below:

Table 3: Definitions of the concept of "computational thinking".

Author	**Definition**
Wing J.M.	"Digital thinking is solving problems, designing systems and understanding human behavior based on the basic concepts of informatics" [8; p. 33].
Aho A.V.	"Digital thinking is the thought processes involved in the formulation of problems, so their solutions can be presented in the form of computational steps and algorithms" [9; p. 834].
Stephenson Sh.	Digital thinking is a problem-solving process [10; p. 4].
Wang P.S.	Numerical thinking is the mental skill of applying computational and computer science concepts, methods, problem-solving techniques, and logical reasoning to solve problems in all areas, including our daily lives. [11; p. 26].
Denning P.J.	Digital thinking involves the mental skills and practices of computational design that allow computers to work as humans do, to interpret and explain the world as a set of information processes [12; p. 37].
Barr W., Stephenson S.	"A computer-implementable approach to problem solving." [13; p. 115].
Rosa S.	"Modeling and thought processes involved in modeling" [14; p. 40].
Ikromova M.N.	It is a way of thinking that is formed during the process of identifying the problem, its solution, information processing tools, describing it in a comprehensible form and obtaining the result. [15; p. 43]
Bahromova M.M.	Digital thinking is a broad outlook, comprehensive thinking, ability to foresee the situation, identify the problem in the situation and choose the method of solving it based on the capabilities of modern technologies in every field, and is necessary for its implementation in the most optimal way. is a form of thinking and a universal mental skill [16; p. 24]

These scientists conducted a number of studies to clarify the elements of "computational thinking". Summarizing their thoughts, we explained the elements of "Computational thinking" as follows:

Table 4: Elements of "computational thinking" and their initial formation period

Elements of digital thinking	Formation age	Characteristics
Pattern recognition	0-3	solving a new problem based on a previously known method of solving
Figurative thinking (topological, projection, metric, orderly, compositional)	3	a form of thinking that emerges from the appearance of 3 clearly existing objects, and it plays an important role in various forms of

		human activity, and most importantly, creativity is so important
algorithmic thinking	4	breaking down a problem into smaller steps and understanding how each step contributes to the overall solution
iterative thinking	5-6	coming from the result of a certain idea, coming to another idea and forming the next idea as a result of a new idea
parallel thinking	6-7	parallel execution of parallel thoughts in the process
logical thinking	6-7	to determine the relationship between various data and conclusions
abstraction and generalization	7	the ability to organize and generalize information using categories, schemas, and cognitive structures to generalize relationships and attributes as opposed to concrete objects
Decomposition	7-8	identify the main components of the problem and understand how they are related to each other
systematic information processing	9-10	information processing, error detection and elimination
automation	11-12	mechanization of problem solving and the use of digital and simulation tools
recursive thinking	12-13	thoughts rely on some thought conclusions

Therefore, some of these elements, in particular, pattern reasoning, figurative thinking, decomposition, iterative thinking, parallel thinking, algorithmic thinking and logical thinking, are naturally formed to a certain extent in preschool age. Their development accelerates the formation of the next elements (abstraction and systematic processing of information) in proportion to age. The thinking of a 7-year-old child cannot accept abstraction. So they think only based on concrete objects. Systematic processing of information is a process that goes with the development of abstraction.

The elements of digital thinking should be developed step by step and without gaps. Abandoned clicks can add complexity to the learner's next step or dampen children's can-do spirit. Or it can lead to a wrong conclusion about the concepts intended to be mastered. The fact that this process is so perfect causes some objections among primary school teachers.

CONCLUSION

The thought processes mentioned above develop naturally with age. Also, the degree of intellectuality of the task before a person has a greater influence on its development. The more attention is paid to the step-by-step development of thinking operations from an early age, the less work (intellectual task) and time can be achieved. As a person gets older, it takes more and more time and effort. A child does not want to simply complete an intellectual task. The best way to solve this type of tasks is to provide them with intellectual tasks and educational games and teach them to think. After all, as Confucius said, "Learning without thinking leads to sonfusion; thinking without learning leads to trouble".

REFERENCES

1. http://www.algolittle.org
2. Атлас новых профессий. – Москва, 2015. –164 b.
3. Ершов А.П., Звенигородский Г.А., Первин Ю.А., Школьная информатика (концепции, состояния, перспективы) // Информатика и образование, 1995. № 1. – С. 3-20.
4. КаплуновичИ. Я. Структура и основныеэтапыразвития образного мышлениявдошкольномдетстве // Вопросыпсихологии, 2004. т. №5. – С. 47-56.
5. Утюмова Е.А. Условияформирования алгоритмическихуменийудетейдошкольного возраста. // Педагогическое образованиевРоссии, 2016, № 3. – С. 94-100.
6. Берман Н.Д., Вычислительное мышление. ЦИТИСЭ, т. 20, № 3, р. 26, 2019., Хеннер К.Е., Вычислительное мышление. Образование и наука, т. 131, № 2, pp. 18-33, 2016.
7. Denning, P. J. (2009). Beyond Computational Thinking. Communications of the ACM, 52(6), 28. doi:10. 1 145/ 1 5 16046. 1 5 16054
8. Wing, J. M. (2006). Computational Thinking. Communications of the ACM, 49(3), 33. doi:10.1145/1118178.1118215 p.33

9. Aho, A. V. (2012). Computation and Computational Thinking. The Computer Journal,55(7), 833–835. doi:10. 1093/comjnl/bxs074 p.834
10. Stephenson, Chris; Valerie Barr. Defining Computational Thinking for K-12 // CSTA Voice. — 2011. — Май (т. 7, № 2). — С. 3—4. — ISSN 1555-2128.
11. Wang, Paul S. From Computing to Computational Thinking. CRC Press, 2016. ISBN 1482217651
12. Denning, P.J. and Tedre, M. Computational Thinking. The MIT Press, 2019.
13. Barr, V., & Stephenson, C. (2011). Bringing Computational Thinking to K-12: What is Involved and What is the Role of the Computer Science Education Community? ACM Inroads, 2(1), 48–54. doi:10.1145/1929887.1929905 p.115
14. Rose S. Developing Children's Computational Thinking using Programming Games. Doctoral. – Sheffield Hallam University. 2019. - 220 p.
15. Ikromova M.N. Maktabgacha yoshdagi bolalarning algoritmik fikrlash ko'nikmalarini shakllantirish metodikasi. PhD diss. Namangan-2023. -124 b.
16. Bahromova M.M. Kompyuter o'yinlari orqali boshlang'ich sinf o'quvchilarida raqamli tafakkur elementlarini shakllantirish metodikasi. PhD diss. Namangan-2023. -137 b.
17. Нажмиддинова, Х. Ё. (2019). Intellectual Computer Games-As A Way Of Improvement Learning Children. Scientific and Technical Journal of Namangan Institute of Engineering and Technology, 1(11), 348-351.
18. Yokubjanovna, N. K. (2023). Teaching Programming Elements To Children. Innuc, 1(1), 4952-4956.