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INFORMATION TECHNOLOGY LITERACY AND ISSUES IN DEVELOPING ITS LEARNING ENVIRONMENT

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ABSTRACT

Information technology literacy has emerged as a fundamental competency for individuals in the 21st century. Since the 1960s, various countries have implemented diverse approaches to integrating information technology education into formal schooling, yet these approaches have evolved alongside rapid technological change. This paper examines international trends and practices in teaching IT literacy, highlighting key shifts in pedagogical perspectives, curriculum design, and technological infrastructure.

In the context of accelerated digital transformation in contemporary society, the study further discusses the current state of informatics education within Mongolia's general education system. Based on global experiences and national needs, the paper proposes conceptual directions for improving the content and structure of informatics curriculum, as well as for developing a supportive digital learning environment in schools.

KEY WORDS: Information technology, information, computer, programming, Logo, internet, database, big ideas in computing.

1. Acquiring Information Technology Literacy and Creating an Environment for Its Cultivation

Today, we live in a world that is constantly and rapidly changing. The widespread availability of the internet and digitalization has transformed our communication and lifestyles, exerting a strong influence on living standards. As a result, many national education systems have simultaneously entered a period of crisis, prompting a collective transition toward new educational technologies and a shift to revised paradigms of educational governance. This situation reflects humanity's growing need to adapt to and master the digital environment that underpins modern information technology.

In response to this need, efforts to introduce children to the digital world began in the late 1960s. During this period, mathematician, programmer, psychologist, and educator Seymour Papert was conducting research on artificial intelligence at the Massachusetts Institute of Technology. Together with Marvin Minsky, Papert co-authored the book *Perceptrons*, which addressed machine learning at a time when the material and technological infrastructure for such research was still underdeveloped.

In 1967, as part of a project initiated by the BBN Corporation aimed at developing children's cognitive abilities through programming, Papert contributed to the creation of the Logo programming language (based on the Lisp language). He introduced a graphical robot—later known as the "Logo turtle"—as a command-driven drawing tool within the language. This innovation shaped a new pedagogical approach to teaching programming to children and

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became an important element of their overall intellectual development.

Consequently, Logo evolved into a unique learning environment that enabled children in dozens of countries to develop algorithmic thinking and problem-solving skills.

In the mid-1970s, Soviet scientist A. P. Ershov initiated the idea of teaching programming to school students, including primary school children, through the programs *Dezhurik* and *Malyar*, which were subsequently implemented across the USSR. Ershov conceptualized programming as the "second essential culture" that humanity must acquire, a position he emphasized in his keynote speech delivered in Lausanne in 1981 [1,2].

Similarly, Seymour Papert was deeply convinced that the use of computers would bring about a fundamental transformation in educational systems. His book *Mindstorms* (1980) exerted a profound influence on educational communities worldwide. Over time, hundreds of variations of the "turtle" (черепашка) concept have been developed and implemented globally. Among them, Scratch—created by Papert's team and his students—has become one of the most widely used environments for introductory programming education [2].

Even today, Papert's turtle continues to exist within its "microworld," where students actively control, explore, and learn from it.

During the 1970s and 1980s, various forms of educational "microworlds" began to be utilized in several major educational centers around the world. For instance, at Stanford University in the United States, Richard Pattis developed and popularized *Karel the Robot*, named after the renowned Czech writer Karel Čapek [3]. Beginning in 1980, this grid-based robot environment was widely used in university-level programming courses.

Currently, a new phase of digital technological development is rapidly unfolding worldwide, and Mongolia has set a strategic goal of becoming a "Digital Mongolia" in the near future. Therefore, it is necessary for the state to initiate comprehensive measures to ensure students in general education schools acquire sufficient computer literacy and to widely integrate electronic computing technologies into the educational process.

2. Appropriate Age for Acquiring Information Technology Literacy

The development of information technology, along with the digitalization of everyday life, education, science, and the economy, has led to a decrease in the age at which children begin to learn informatics and programming. Consequently, there is a growing global trend to introduce digital and computational learning from the preschool level. This perspective was already discussed by Seymour Papert and A. P. Ershov more than four decades ago.

The school program on *Computational Thinking* includes the fundamentals of informatics, algorithms, and programming. The general conceptual framework for its implementation has been clearly outlined in the works of the prominent Russian educator A. L. Semenov [4]. Under his leadership, for nearly 30 years Russia has developed a comprehensive set of textbooks, teaching methodologies, and instructional materials for primary school education, including the series *Informatics* and *Informatics and Mathematics*. In 2019, the textbook *Informatics for Grades 1–4* was published and introduced into school practice. According to Semenov, programming should not be viewed merely as a "second literacy," but rather as an essential component of holistic education in the 21st century.

Therefore, many countries around the world are now addressing the challenge of introducing foundational information technology knowledge to preschool children through visual and interactive learning approaches [4,5,6].

3. Digitalization Policy

Today, the primary goal of general education is to develop 21st-century skills and to cultivate learners' awareness of globally relevant knowledge, competencies, and practices. Global orientations are changing very rapidly. In this context, the concept of "Big Ideas" has recently emerged, referring to high-level, integrative principles that unify different domains of knowledge. Examples include the concepts of energy, heredity, and the mathematical description of physical processes.

The notion of Big Ideas has arisen partly in response to the overwhelming "ocean of facts" in conventional science education. Big Ideas constitute an essential part of how people conceptualize the world; without them, our understanding of reality would be fragmented, and our behavior within the world would be fundamentally different. Therefore, from an epistemological perspective, the Big Ideas of digital knowledge are becoming increasingly significant.

Twenty-first-century skills and orientations should be aimed at enabling learners to engage meaningfully with the world and to acquire knowledge and competencies that are both relevant and applicable to real-life activities. In this regard, it is worth recalling the statement attributed to George Halifax in the 17th century: "Education is what remains after one has forgotten most of what one has learned in school." This idea was later echoed by renowned physicists such as Albert Einstein and Max von Laue. This perspective is especially relevant today, as learning, communication, and activity are taking place within increasingly complex and interconnected environments.

In other words, in the 21st century, individuals with broad and integrated knowledge play a crucial role, and the foundation of such knowledge lies in digital competence based on *Computational Thinking*.

Modern informatics education can provide individuals with the following opportunities:

1. To develop many of the key competencies required in the 21st century, including collaboration skills.
2. To expand personal intellectual capacity through digital knowledge, particularly by using Big Ideas as a framework for understanding the world and as part of general culture.
3. To enable learners to solve complex, diverse, and intellectually stimulating problems using structured analytical frameworks.

4. The Role of the Environment: Content of Informatics Education

The foundation of Mongolia's transition toward a digital nation largely depends on the content of informatics education implemented at the level of general education. At present, the curriculum applied in general education schools lacks a unified national standard, which in turn affects information technology programs in higher education institutions. As a result, each school

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conducts instruction based on its own capacities and discretion, indicating the need for a coherent national policy to achieve the goal of a Digital Mongolia. Therefore, given the critical role of informatics education in general education for building a digitally advanced society, this paper proposes one possible version of a curriculum framework.

The content of the informatics curriculum for general education schools is formulated as follows:

1. Information
   1.1. Classification of information
   1.1. Digital and analog information
2. Information Technology
   2.1. Methods of information processing
   2.2. Similarities between information technology and material production technologies
   2.3. Classification of information tools Fundamentals of computer modeling
   2.4. Basic concepts of computer modeling
   2.5. Classification of models
   2.6. Modeling
   2.7. Stages of modeling
   3. Number Systems
   3.1. Types of number systems
   3.2. Representation of numbers in decimal and Roman systems
   3.3. Principles of positional number systems
   3.4. Alphabet of number systems
   3.5. Representation of numbers from 0 to 15 in different number systems
   3.6. Expanded form of numbers
   3.7. Compact form of numbers
   3.8. Fixed-point number representation
   3.9. Floating-point number representation
   3.10. Addition in arbitrary number systems
   3.11. Subtraction in arbitrary number systems
   3.12. Addition table in binary system
   3.13. Addition table in octal system
   3.14. Addition table in hexadecimal system
   3.15. Division of fixed-point numbers in arbitrary systems
   3.16. Multiplication of fixed-point numbers in arbitrary systems
   3.17. Multiplication table in binary system
   3.18. Multiplication table in octal system
   3.19. Multiplication table in hexadecimal system
   3.20. Addition and subtraction of floating-point numbers
   3.21. Multiplication of floating-point numbers
   3.22. Division of floating-point numbers
   3.23. Conversion of integers from base P to base Q
   3.24. Conversion of decimal fractions from base P to base Q
   3.25. Conversion of floating-point decimals from base P to base Q
   3.26. Conversion of mixed numbers from base P to base Q
   3.27. Power table of number system bases
4. Computer
   4.1. Concept of computer
   4.2. Types of computers
   4.3. Computer architecture
   4.4. Input devices
   4.5. Output devices
   4.6. Data storage devices
   4.7. Optical storage devices
   4.8. Central processing unit
   4.9. Motherboard
   4.10. Operating system
   4.11. Drivers
   4.12. Utilities
   4.13. Application software
   4.14. Software tools
5. Representation of Information in Computers
   5.1. Units of information measurement
   5.2. Power table
   5.3. Fixed-point number representation
   5.4. Computer representation of negative numbers
   5.5. Direct code
   5.6. Complement code
   5.7. Character encoding
6. Application Software
   6.1. Word processor
   6.2. 6.2. Basic elements of text documents
   6.3. 6.3. Spreadsheet
   6.4. 6.4. Basic elements of spreadsheets
   6.5. Spreadsheet functions
   6.6. Creating charts and graphs
   6.7. Databases
   6.8. Database management systems
7. Fundamentals of Animation
   7.1. Types of animation
   7.2. Computer animation
8. Computer Networks
   8.1. Local area network
   8.2. Network terminal
   8.3. Components of local networks
   8.4. Network architecture
   8.5. Wireless networks
   8.6. Internet
   8.7. World Wide Web (WWW)
   8.8. Information search on the internet
   8.9. Electronic mail
9. Mathematical Foundations of Informatics
   9.1. Data representation
   9.2. Data types
   9.3. Boolean algebra
   9.4. Set theory
   9.5. Information quantity
10. Programming
   10.1. Programming languages
   10.2. Algorithms
   10.3. Flowcharts
   10.4. Types of algorithms
   10.5. Procedures and functions
   10.6. Variable
   10.7. Expressions

It is argued that implementing a curriculum with this content in general education schools would serve as a fundamental basis for the successful realization of the Digital Mongolia initiative.

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